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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
U.S. Department of the Interior

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The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 30, 1989.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

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06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

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08 ENGINEERING WORKS

Includes the following Groups: Structures; Hydraulics; Hydraulic Machinery; Soil Mechanics; Rock Mechanics and Geology; Concrete; Materials; Rapid Excavation; Fisheries Engineering.

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

HYDROPHOBIC ORGANIC COMPOUNDS ON SEDIMENTS: EQUILIBRIA AND KINETICS OF SORPTION,
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
For primary bibliographic entry see Field 5B.
W88-09075

ELEMENT CYCLING IN WETLANDS: INTERACTIONS WITH PHYSICAL MASS TRANSPORT,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W88-09081

GROUND-SURFACE WATER TECHNICAL AND QUASI-LEGAL RELATIONSHIPS,
Tipton and Kalmach, Inc., Denver, CO.
R. E. Darr.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 177-180, 1 tab, 5 ref.

Descriptors: *Surface-groundwater relations, *Legal aspects, *Water law, *Groundwater management, Glover equations, Wells, Computer programs, Model studies, Appropriation, Water rights.

In order to administer groundwater under the doctrine of prior appropriation (when groundwater is considered tributary to surface water), it is necessary to use technical procedures to determine the time and rate of depletion to surface water. The Glover equations are useful in predicting the impact of pumping a well in hydraulic connection with the surface water body. Modeling is also used to define the time and rate of surface impact. The laws to define what is tributary vary from state to state. In Colorado, these laws have been written by the Legislature and the decisions of the state Supreme Court. Since surface water was developed prior to the drilling and using of water from wells on most surface water drainages, surface water has priority over groundwater use in most areas. Therefore, in order to develop groundwater and other junior water rights, the state Legislature has passed a law allowing for augmentation plans. These plans are unlimited as long as there is no injury to senior vested water rights. Applying these criteria to the use of groundwater allows for the orderly development of water in states that administer their water using the doctrine of prior appropriation. However, the question of the relevance of these criteria is seldom raised because the regulators and water judges feel secure with them. In many cases, the above-referenced equations and models are inappropriately applied and bogus results allow for too little or too much water to be diverted by the wells. (See also W88-09240) (Cassar-PTT)
W88-09261

INCORPORATION OF PREDICTED FUTURE CLIMATIC EFFECTS INTO SIMULATIONS FOR GROUND WATER RESOURCE EVALUATIONS,
L. R. Silka, and A. G. Kretschek.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 286-294, 7 fig, 1 tab, 24 ref.

Descriptors: *Geohydrology, *Water budget, *Simulation, *Resources management, *Groundwater management, *Climatic data, Prediction, Evaluation.

Most predictions of groundwater resources are based upon the climatic patterns of the past century and the assumption that these patterns are static. If this important factor is neglected in planning, serious errors may be incorporated into the planning process. It is generally agreed that climate will undergo fluctuations in the near future, particularly a general warming trend; however, contention does exist concerning the magnitude and direction of these changes. For most hydrologic projects a 50 to 100-year climatic record is needed; for waste disposal, hundreds to thousands of years. For the Western U.S. hydrologic records go back only about 100 years; most continuous records for the same station are no longer than 40 years. Both proxy and historic records can be used to predict climatic events. For the predicted warming trend, the outlook for the status of water resources in the central and western states is not optimistic. A conservative scenario would demand that precipitation is diminished and recharge to groundwater drastically reduced. Conjunctive simulation of surface and groundwater becomes even more important. For example, the past simplifications in groundwater modeling of representing surface water bodies as constant head nodes should be changed to variable flux, head dependent boundaries. (See also W88-09240) (Cassar-PTT)
W88-09272

MONO BASIN GEOLOGY AND HYDROLOGY,
Los Angeles City Dept. of Water and Power, CA.
M. L. Blevins, and J. F. Mann.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 326-339, 15 fig, 4 tab, 18 ref.

Descriptors: *Geohydrology, *Groundwater budget, *Lakes, *California, *Mono Basin, Geohydrology, Water supply, Model studies, Water level fluctuation, Groundwater recharge, Water budget, Precipitation, Groundwater, Diversion, Recharge, Los Angeles.

An understanding of the Mono Basin characteristics is important because this region is an important source of 100,000 acre-feet per year of water diverted into the Los Angeles Aqueduct system. As a result the lake level has declined 1.5 ft each year, and the ecosystem has become the focus of increased scientific investigation. The basin is a hydrologically closed drainage area of 750 sq mi, half hill and mountain areas and the other half occupied by the valley fill areas and Mono Lake. The valley floor is much flatter than the watershed areas and slopes in all directions toward the lake. All water reaching the lake is stored or evaporated. Mono Basin is ringed by steep mountains 13,000 ft elevation compared with the lake surface elevation of 6372 in 1982. The water level of the lake historically has fluctuated with the amount of runoff available from the snowfed streams. Starting in a dry period in 1924, the lake water level has declined gradually. Water exports starting in 1941 accelerated this decline. As of August 1983 the lake elevation was 6378 ft; the area, 64 sq mi; and the volume, 2.3 million acre-feet. The lake size is projected to stabilize in 80 to 100 years at an elevation of 6330 ft, area of 38 sq mi, and volume of 800,000 acre-feet. A computer model was developed to study potential major changes relating to the water balance of the lake and basin. (See also W88-09240) (Cassar-PTT)
W88-09276

PALAEOHYDROLOGY IN PRACTICE: A RIVER BASIN ANALYSIS.
John Wiley and Sons, New York. 1987. 370 p. Edited by K. J. Gregory, J. Lewin, and J. B. Thornes.

Descriptors: *Geomorphology, *Paleohydrology, *River basin analysis, *Sedimentology, *Climatology, Rivers, History, Geohydrology, Water resources, Hydrologic models, Model studies, Severn River, England.

One of the principal goals of the International Geological Correlation Programme (IGCP)is to encourage international research on geological problems related to the identification and assessment of natural resources and the improvement of man's environment. This volume, concerned with IGCP Project 158 on Paleohydrology, relates to water as a natural resource. England's Severn River Basin, past and present, is described from hydrological, sedimentological, and climatological viewpoints. Some general concepts of paleohydrology and river evolution are also treated. It is the interaction between that resource and environment that is the subject of study and the interaction can usefully provide clues as to how the environment may be improved. At a time when it is acknowledged that global environments may be changing as a result of the impact of human activity, it is important that we are able to learn from the past. This book emphasizes that knowledge about environmental evolution should be utilized to extend models of environmental change. (See W88-09361 thru W88-09373) (Lantz-PTT)
W88-09360

INTRODUCTION,
Southampton Univ. (England). Dept. of Geography.
K. J. Gregory.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 1-15, 1 fig, 61 ref.

Descriptors: *Paleohydrology, *Severn River, *Wye River, Geohydrology, Natural resources, Environmental protection, Geology, Water resources, England.

The scientific achievements of this IGCP Program (1978-82) were classified in 1983, into three categories concerned with: (1) projects related to better knowledge of geological processes, correlations and concepts; (2) projects related to more effective protection and utilization of the environment; and (3) projects related to more efficient identification and assessment of resources. Research projects in these categories include fundamental investigations of the processes that have governed the development of the earth's structure as related to the solution of practical problems concerned with the distribution of natural resources or the impact of geological factors on the human environment. An important feature of all IGCP projects is the way in which objective non-governmental scientific participation can utilize results of research on relevant problems so that international research activity can be further developed and strengthened. Studies of environmental change have not always been able to relate to time and space in the most appropriate ways. It is comparatively easy to attempt a review of paleohydrology in Britain, because prior to the 1970's there was little coordinated research on paleohydrology. Studies of the Severn/Wye drainage basin and historical events of significance to the river are reviewed. The selection of this particular drainage basin for paleohydrology studies is discussed. (See also W88-09360) (Lantz-PTT)
W88-09361

MODELS FOR PALAEOHYDROLOGY IN PRACTICE,
Bristol Univ. (England). Dept. of Geography.
J. B. Thornes.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 17-36, 5 fig, 52 ref.

Descriptors: *Paleohydrology, *Rivers, *Erosion, *Sediment yield, *Hydrologic models, *Severn River, Model studies, Vegetation, Snow, Ice, Forests, Climates, Geohydrology, Catchment basins, United Kingdon.

The Severn Basin (United Kindgom) paleohydrology can be defined in terms of three major environments are: (1) Snow- and ice-dominated, to about 10,000 BP; (2) Forest-dominated, to about 5,000 BP; and (3) Anthropogenically-dominated to an increasing extent since 5,000 BP. Some of the major available models (1) conceptual models which substantially improve knowledge about the theory of basic processes and interrelationships

between them; (2) paleohydrologic models based on physical reasoning, parameterized from field data and applied experimentally to evaluate assumptions about vegetation or climatic changes; and (3) coarser scale models which are parameterized at a level which may be matched by paleohydrological data) for considering hydrological response to climatic controls in these three environments have been considered in this chapter. Although a general model of river basin response which can be driven by climatic forcing functions and modified by human activity, will probably never be reached, paleohydrologists can and should be making more use of even approximate and deductive models. What has changed is the greater understanding of the ecological controls of erosion and their importance. This will eventually shift paleohydrology away from a preoccupation with pollen diagrams and fluvial sediments to dynamic modelling of the catchment ecological systems in a way that provides a better understanding of water and sediment yield. (See also) W88-09360) (Lantz-PTT)
W88-09362

CONTEMPORARY RIVER: THE BASIN,
University Coll. of Wales, Aberystwyth.
For primary bibliographic entry see Field 2E.
W88-09363

SPATIAL VARIABILITY IN THE CLIMATE OF THE SEVERN BASIN: A PALAEOHYDROLOGICAL PERSPECTIVE,
Birmingham Univ. (England). Dept. of Geography.
D. M. Lawler.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 49-78, 11 fig, 3 tab, 109 ref.

Descriptors: *Climatology, *Paleohydrology, *Severn River, *Wales, Catchment basins, Rainfall, Hydrologic regime, Precipitation, Temperature, Frost, Geomorphology, Seasonal variation, Spatial variation, Maps.

A series of maps are used to describe the nature of spatial variability of climatological parameters within the Severn Basin catchment of a few key meteorological elements most pertinent to paleohydrological investigations. These maps are intended t o show how a few climatic elements (mean annual rainfall, rainfall seasonality, rainfall intensity, effective precipitation, antecedent precipitation, mean monthly annual temperature and frost indices) may vary widely in magnitude across the catchment. A number of controls of these spatial patterns are discussed. The overall picture at a very general level is one of increasing potential in hydrological and geomorphological activity as one moves westward across the Severn Basin from some point on the easterly periphery: such a transect would reveal a steadily increasing annual rainfall receipt, with individual rainfall events achieving greater intensity, a more pronounced concentration of rainfall into the winter half of the year, a possible greater tendency for heavy rainstorms to fall in winter when soil moisture deficits are smallest and contributing source areas more strongly developed, a lower proportion of precipitation evaporated back into the atmosphere, and a greater incidence of frost. If this increasing meteorological dynamism is coupled with the steeper slopes of the western uplands and the readily-available sediment supplies left as legacy of periglacial activity, then the potential for increased hydrological and geomorphological work in these areas becomes evident. (See) also W88-09360)(Lantz-PTT)
W88-09364

PRESENT-DAY HYDROLOGY OF THE RIVER SEVERN,
Severn-Trent Water Authority (England).
For primary bibliographic entry see Field 2E.
W88-09365

CLIMATIC CHANGE OVER THE LAST MILLENIUM IN CENTRAL BRITAIN,
Birmingham Univ. (England). Dept. of Geography.
D. M. Lawler.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 99-129, 13 fig, 1 tab, 95 ref.

Descriptors: *Climatology, *Human impacts, *Rivers, *Sediments, *Paleohydrology, *Climates, *United Kingdom, *Precipitation, Hydrologic regime, Sedimentology, History, Geohydrology, Geomorphology, Time series analysis.

In relation to paleohydrology, the study of climatic change may feature in at least two ways. First, if independent assesments of climatic change are available they may be used to assist inference of hydrological changes. Second, climatic change may itself be inferred from changes in hydrology, sediments or channel form, uncovered through, for example, stratigraphical analysis or paleohydraulic reconstruction. The main shifts of climate over the last millenium identified in Central Britain and particularly the Severn Basin are reviewed with an emphasis placed on the definition of patterns of change and variability, rather than on their causes or implications. The chapter provides material on the relative impact of man and climatic changes on hydrological, sedimentological and geomorphological changes. (See also W88-09360) (Lantz-PTT)
W88-09366

ENVIRONMENTAL CHANGE AND HYDROLOGICAL RESPONSE: FLOODING IN THE UPPER SEVERN CATCHMENT,
University Coll. of Wales, Aberystwyth. Dept. of Geography.
G. Higgs.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 131-159, 10 fig, 6 tab, 28 ref.

Descriptors: *Paleohydrology, *Historic floods, *Rivers, *Hydrologic regime, *Flooding, *Severn River, *United Kingdom, Catchment areas, Climates, Land use, Agriculture, Flood frequency, Agriculture, Flashy streams, Seasonal variation, Time series analysis.

The number of flood events in the Severn catchment has exhibited a general increase during the past 60 years. This is directly related to variations in heavy rainfall in the catchment stemming from the mid 1920s. Since 1968, however, there has been a decline in flood frequencies and magnitude, related to a decrease in winter precipitation, but also to a change in the nature of flooding in the upper reaches, with a tendency to a more 'flashy' regime. Land use changes, and in particular agricultural drainage and pasture improvement in the catchment upstream of Caersws, can be suggested as possible reasons for a more rapid upstream hydrological response. The characteristics of flood magnitudes and frequency are highly sensitive to climatic variations, and in particular to changes in circulation regimes, as well as catchment changes, and the effects of the latter will vary according to the areas involved and the location of change within the catchment. By establishing the relationship between contemporary climatic and land use changes and hydrological response, evaluations of past responses of river systems to environmental changes can be attempted. Such relationships are often very complex. The effects of land use change vary according to the return periods of the flood considered, with negligible consequences for the less frequent, larger magnitude floods. Climatic change may be important through direct consequences on the recurrence intervals of floods, or on longer timescales, through the resulting displacement of vegetation formations. Results from the present study suggest that fluctuations in flood frequency in the historical time period are the norm and that such fluctuations accompany a continuous variation in climatic and catchment factors demonstrating that stability or temporal equilibrium is far from obvious, and that 'fine tuning' of paleohydrology estimates to such factors is by no means straightforward. (See also W88-09360) (Lantz-PTT)
W88-09367

PALAEOHYDROLOGICAL SYNTHESIS AND APPLICATION,
Southampton Univ. (England). Dept. of Geography.
K. J. Gregory, and J. Lewin.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 341-360, 2 fig, 2 tab, 70 ref.

Descriptors: *Paleohydrology, *Hydrologic regime, *History, *England, Rivers, Land use, Forestry, Model studies, Severn River, Wye River, Catchment areas, Data collections, Greenhouse effect, Prediction.

Paleohydrological synthesis is confronted by at least four major problems: (1) scarcity of data; (2) artificial separation of the past from the present; (3) fragmentation of scientific efforts into various disciplines; and (4) advances in science that occur during the course of a paleohydrological study and must be taken into account. The nature and extent of the data available on the Severn-Wye drainage basin is reviewed and the ways these data have been employed in paleohydrological studies are discussed. Anticipated shifts in the amount of land use for agriculture, amenity and forestry are dramatic changes for which there is no recorded precedent. Information from paleohydrology may be needed to outline the possible dimensions of the effects which might be anticipated. Climatic changes now expected in the early years of the twenty-first century as a result of the greenhouse effect and increasing carbon dioxide concentrations could mean that an analogue that is beyond historical hydrology should be sought. To optimize the use of paleohydrological information in relation to interpretations for the future it is necessary to establish clearer transfer functions between the environmental components in the paleohydrological system. Once models have been further developed it is possible that such models, perhaps utilizing energy transfer, may be the basis for interpretation of the future in the light of the greater knowledge of the past. (See also W88-09360) (Lantz-PTT)
W88-09373

HISTORY OF HYDROLOGY.
American Geophysical Union. Washington, DC. History of Geophysics, Vol. 3. 1987. 122 p.

Descriptors: *Geophysics, *Geohydrology, *History, *Biography, *Bibliography, Equations, Darcys Law, Paleohydrology, Aquifers, Brines, Sedimentation, Radioactivity, Soil water, Clays.

This book is a compilation of papers presented at the first two symposia sponsored by the Committee on History and Heritage of Hydrology of the American Geophysical Union. It includes both original papers and papers previously published elsewhere. Topics include the following: Physical theory of Darcy's Law and its application to entrapment of oil and gas; the Alexandrian equation; early attempts at theory formation in fluid mechanics; Medieval Saint Barbara worship and professional traditions in early mining and applied earth sciences; paleoflood hydrology in the United States, 1800-1970; history of fluvial paleohydrology; discovery of the aquifers in the New Jersey coastal plain in the nineteenth century; early twentieth-century investigations of the radioactivity of waters in North America; history of thought on the origin of subsurface sedimentary brines; soil water physics; R. E. Moore and the Yolo light clay; contributions of Robert E. Horton; and Max Leggette, pioneer of hydrology consultants. (See W88-09406 thru W88-09414) (Cassar-PTT)
W88-09405

SUMMARY OF THE GLOBAL WEATHER EXPERIMENT WORKSHOPS ON THE HYDROLOGICAL CYCLE AND DATA ASSIMILATION,
Utah Univ., Salt Lake City. Dept. of Meteorology.
J. Nogues-Paegle, and R. Daley.
GARP Topics BAMIAT, Vol. 4, No. 86, p 377-382, April 1988. 2 ref.

Descriptors: *Hydrologic cycle, *Hydrologic data collections, *Global Weather Experiment, *Global Atmosphere Research Program, *Weather Data collections, *Rainfall rate, Workshops, Humidity, Numerical analysis, Atmosphere.

Two workshops were organized by the First GARP Global Experiment Panel of the U.S. National Committee for Global Atmosphere Research Program (GARP) of the National Academy of Sciences, to study hydrological cycles and data assimilation. The hydrological cycle workshop was divided into three sessions. One session addressed diagnostic studies of the hydrological cycle. Another session investigated the simulation of the hydrological cycle by numerical models. The third session concentrated on observational systems used to measure and estimate hydrological cycle components. The data assimilation workshop discussed the state of the art in data assimilation techniques, studies that made use of assimilated data, and future directions in this field. Various recommendations resulted from these workshops, and are presented. (E. Stoehr-PTT)
W88-09561

MAXIMAL DISCHARGES OBSERVED IN ISRAEL,
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
A. Ben-Zvi.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 15-19, February 1988. 2 fig, 1 tab, 3 ref.

Descriptors: *Maximum flow, *Rainfall-runoff relationships, *Runoff, *Geohydrology, Israel, Mathematical equations, Mathematical studies, Catchment areas, Lithology, Precipitation, Soil types, Geologic formations, Geology, Slopes, Geologic units.

Maximal discharges observed in Israel since 1938 were plotted on log-log paper against the catchment area of the measuring sites in order to provide a method which is suitable for the physiographic conditions in Israel which described the relationships among catchment area of the watershed, physiographic region and maximal discharges. The important physiographical properties were represented by the lithology of the upper geological unit and by the depth of precipitation. Four envelope lines, parallel to one another, were drawn on the paper. The formula of these lines was found in terms of maximal observed discharge, the catchment area and an empirical coefficient which varied from 1.7 to 4.5 depending on the precipitation and the lithology of the watershed. High discharges were observed where the mean annual depth of precipitation was low. With respect to the lithological units found in Israel, the highest discharges were observed where the lithology was of thinly deposited limestone and the surface slopes were steep. The lowest maximal discharges were observed where the lithology was heavily deposited limestone and dolomite, or conglomerates. No high discharges were observed from watersheds where the lithology was Holocenean sand. In general, impervious, steeply sloped surfaces generated higher discharges than pervious or mildly sloped surfaces. (Wood-PTT)
W88-09701

RELATIONSHIPS BETWEEN INDIAN OCEAN SEA SURFACE TEMPERATURE AND THE RAINFALL OF SRI LANKA,
Tsukuba Univ. (Japan). Inst. of Geoscience.
For primary bibliographic entry see Field 2B.
W88-09867

STATISTICAL RELATION BETWEEN RELATIVE HUMIDITY AND THE GMS OBSERVED CLOUD AMOUNT,
Japan Meteorological Agency, Tokyo. Numerical Prediction Div.
K. Saito, and A. Baba.
Journal of Meteorological Society of Japan JMSJAU, Vol. 66, No. 1, p 187-192, February 1988. 6 fig, 2 tab, 6 ref.

Descriptors: *Weather satellites, *Remote sensing, *Relative humidity, *Clouds, *Model studies, *Prediction, *Statistical model, Atmospheric physics, Meteorological data collection, Equations, Mathematical studies.

In numerical prediction models, cloud amount is one of the main quantities that determines radiative fluxes. On the other hand, recent models have a tendency to represent cloud amounts by quadratic functions of the relative humidity. The statistical relation of cloud amounts to relative humidity is investigated by using GMS observed cloud data, and the properties of a derived equation are discussed from a statistical aspect. A statistical relation between relative humidity and cloud amount has been derived by using satellite and aerological data. The GMS observed cloud amount is classified according to height, and compared with relative humidity of the TEMP-A data. The distributions of cloud amount to relative humidity are somewhat loose, but it can be considered that the average value of a classified cloud amount is expressed by a quadratic function of the relative humidity. These functions, for the different classifications, have certain critical relative humidities above which cloud increases. The value tends to be larger for lower cloud levels. This relation can be used in the cloud cover parameterization of numerical prediction models. (Alexander-PTT)
W88-09869

INTERANNUAL VARIATIONS OF SEA SURFACE TEMPERATURE OVER THE ARABIAN SEA AND THE INDIAN MONSOON: A NEW PERSPECTIVE,
Indian Inst. of Science, Bangalore. Centre for Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W88-09870

OCCURRENCE, DISTRIBUTION AND AVAILABILITY OF PAH IN SURFACE WATERS AND SEDIMENTS,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 5B.
W88-09906

HYDROGEOCHEMISTRY OF CHLORIDE IN AN UPLAND CATCHMENT IN MID-WALES,
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.
B. Reynolds, and A. B. Pomeroy.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 19-32, May 1988. 6 fig, 4 tab, 20 ref.

Descriptors: *Soil water, *Tracers, *Chlorides, *Geohydrology, *Rainfall, Catchment areas, Temporal distribution, Chemical analysis, Climatology, Hydrology, Streams, Ions.

Data describing the variations in Cl concentration in bulk precipitation, soil waters and stream water for over six years at a remote upland site in mid-Wales, U.K. are presented. Throughfall and filter gauge data indicate that marine aerosols and cloud water are an important component of the atmospheric inputs to the site. Concentrations of Cl in bulk precipitation are highly variable over time but this variation is progressively damped through the soils to the streams. Trends in soil and stream water Cl concentrations over the period are attributed to the impact of climatological variations on the hydrology of the catchment. The effects of this trend on annual Cl mass balances are discussed and highlight the need for long-term catchment studies. (Author's abstract)
W88-09912

STORAGE-EFFECTIVE DRAINAGE RUNOFF MODEL,
Alberta Dept. of Environment, Edmonton.
G. Holecek.
Journal of Hydrology JHYDA7, Vol. 98, No. 3/4, p 295-314, April 15, 1988. 13 fig, 1 tab, 2 ref.

Descriptors: *Rainfall-runoff relations, *Watershed management, *Deforestation, *Model studies, Storage-effective drainage model, Catchment basins, *Forest hydrology, *Mathematical models, Hydrologic models, Regression analysis, Mathematical models, Spring Creek, Runoff, Hydrographs, Statistical analysis, Basins, Storms, Alberta, Canada.

The storage-effective drainage (SED) runoff model was developed to assist in the research objectives of Alberta Environment's Spring Creek Experimental Watershed Project. The project's primary mandate was to identify the effects of large scale deforestation in a pristine boreal forest on the hydrologic cycle. During the research pretreatment phase it was observed that: (1) during two consecutive water years the basin had a 50% difference in annual input but displayed a 700% difference in annual output; and (2) two storms, with the same magnitude and intensity, generated output responses that differed by a multiple of 500. Recognizing the wide range of watershed responses to a given input it is impossible to distinguish the effects of deforestation using the established investigative tools of regression and statistical analyses particularly when dealing with small data samples. For this reason the SED model, which uses changes in basin storage conditions as a means of accurate runoff modeling and reconstitution, was developed. (Author's abstract)
W88-09978

COMPUTER-AIDED APPROACH TO AGRICULTURAL FLOOD HAZARD MANAGEMENT IN FLORIDA.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6A.
W88-10015

INFLUENCE OF SPATIAL VARIABILITY AND SCALE EFFECTS ON THE PARAMETERIZATION OF HYDROLOGIC RESPONSE,
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 2E.
W88-10024

EFFECTIVENESS OF BMPS FOR STORMWATER MANAGEMENT IN URBANIZED WATERSHEDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W88-10029

STUDY OF RUNOFF AND EROSION PROCESSES USING LARGE AND SMALL RAINFALL SIMULATORS,
New Mexico State Univ., Las Cruces. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W88-10045

RAINFALL-RUNOFF DATA FOR SOMERSET COUNTY, NEW JERSEY,
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 2E.
W88-10049

HYDROLOGY OF THE WHITE TAIL BUTTE AREA, NORTHERN CAMPBELL COUNTY, WYOMING,
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 4C.
W88-10052

INVESTIGATION OF TECHNIQUES TO ESTIMATE RAINFALL-LOSS PARAMETERS FOR ILLINOIS,
Geological Survey, Urbana, IL. Water Resources Div.
L. S. Weiss, and A. L. Ishii.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources In-

vestigations Report 87-4151, 1987. 60 p, 9 fig, 14 tab, 13 ref.

Descriptors: *Rainfall-runoff relationships, *Excess rainfall, *Illinois, Flood hydrographs, Discharge hydrographs.

An attempt was made by the U.S. Geological Survey to develop parameter-estimation techniques for two rainfall-loss computation methods used in the U.S. Army Corps of Engineers' flood-hydrograph model (HEC-1). Six rainfall-loss parameters were investigated - four for the Exponential Loss-Rate method and two for the Initial and Uniform Loss-Rate method. Multiple-regression analyses using data from 616 storms at 98 gaged basins were used to attempt to develop parameter-estimation techniques for ungaged basins in Illinois. Techniques were evaluated using 102 storms at 36 uncalibrated gage basins. Estimated unit-hydrograph and rainfall-loss parameters were used to compute discharge hydrograph characteristics, which were compared with characteristics of observed discharge hydrographs. Seventy and 50% of the simulations using the Exponential Loss-Rate and the Initial and Uniform Loss-Rate methods, respectively, produced valid hydrographs. Model-sensitivity analyses to one standard error of estimate indicate that the storm-dependent rainfall-loss parameters are most significant in reproducing the sum of incremental flows and peak discharge. Time of concentrations and storage coefficient are significant in reproducing time to peak discharge and peak discharge, respectively. The small percentage of variation explained by the estimation techniques and the evaluation results using 102 storms indicates that a large degree of uncertainty exists in the computed hydrographs. (USGS)
W88-10064

2B. Precipitation

DEPOSITIONAL ASPECTS OF POLLUTANT BEHAVIOR IN FOG AND INTERCEPTED CLOUDS,
California Inst. of Tech., Pasadena. Dept. of Environmental Engineering Science.
For primary bibliographic entry see Field 5B.
W88-09069

SPATIAL VARIABILITY IN THE CLIMATE OF THE SEVERN BASIN: A PALAEOHYDROLOGICAL PERSPECTIVE,
Birmingham Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09364

SAMPLING AND ANALYSIS OF RAIN.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 7B.
W88-09387

VARIABILITY OF THE PRECIPITATION PROCESS IN TIME AND SPACE,
Maryland Univ., College Park. Inst. for Physical Science and Technology.
For primary bibliographic entry see Field 7A.
W88-09388

SIMULATED PRECIPITATION REFERENCE MATERIALS: MEASUREMENT OF PH AND ACIDITY,
National Bureau of Standards, Washington, DC.
For primary bibliographic entry see Field 5A.
W88-09389

PRACTICAL QUALITY CONTROL OF RAIN-WATER ANALYSES,
College of William and Mary, Williamsburg, VA. Dept. of Chemistry.
For primary bibliographic entry see Field 7C.
W88-09390

ANALYSIS OF RAIN BY ION CHROMATOGRAPHY,
Dionex Corp., Sunnyvale, CA.
For primary bibliographic entry see Field 5A.
W88-09391

ATMOSPHERIC SULFUR ANALYSIS USING RATEOMETRIC COLORIMETRY,
Houston Atlas, Inc., Houston, TX.
C. L. Kimbell, and C. L. Kimbell.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 41-49, 7 fig, 6 ref.

Descriptors: *Water analysis, *Air pollution, *Sulfur, *Acid rain, *Colorimetry, Chemical analysis, Pollutant identification, Monitoring, Titration.

A method for measuring sulfur compounds in liquid and gases from 0 to 100 parts per billion by volume is applicable to atmospheric sulfur measurements. The primary sensing method involves the colorimetric chemical reaction between hydrogen sulfide and lead acetate. An electronic system was designed that measures the rate of change of color in a 3-min. analysis cycle. All sulfur types are converted to hydrogen sulfide using a hydrogenolysis system to thermally crack the sample. Equipment using this method (colorimetry, coulometric titration analyzers, and hydrogen sulfide analyzers) is suitable for mobile mounting in an automobile, helicopter, or airplane. (See also W88-09387) (Lantz-PTT)
W88-09392

APPLICATIONS OF WITHIN-EVENT PRECIPITATION CHEMISTRY MEASUREMENTS,
Brookhaven National Lab., Upton, NY.
For primary bibliographic entry see Field 7A.
W88-09393

UPDATING PROCESS IN PRECIPITATION QUALITY NETWORKS,
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 7A.
W88-09396

FREQUENCY DISTRIBUTION OF THUNDERSTORM DURATIONS,
North Carolina Univ., Chapel Hill.
P. J. Robinson, and D. R. Easterling.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 1, p 77-82, January 1988. 4 fig, 3 tab, 14 ref.

Descriptors: *Meteorological data, *Storm duration, *Duration, *Precipitation, *Rainfall, *Thunderstorms, *Storms, Rainstorms, Rainfall distribution, Data collections.

The frequency distributions of thunderstorm durations were analyzed for 30 years at 36 stations in the U.S. to develop an appropriate summarizing statistic for durations. The incomplete gamma function provides a close fit to the observations for all stations and can be used to specify for any station the probability of encountering storms with any selected range of durations. Preliminary analyses of the spatial and seasonal distribution of the coefficients suggested that regional clusters occur, indicating the potential for the development of a nationwide thunderstorm duration climatology. Storms lasting 3 hours or longer are infrequent but display a spatial pattern differing from that of short duration storms. (Author's abstract)
W88-09533

SATELLITE INFRARED TECHNIQUE TO ESTIMATE TROPICAL CONVECTIVE AND STRATIFORM RAINFALL,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
R. F. Adler, and A. J. Negri.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 1, p 30-51, January 1988. 9 fig, 7 tab, 31 ref.

Descriptors: *Precipitation, *Infrared imagery, *Rainfall, *Remote sensing, *Satellite technology, *Radar, Weather satellites, Tropical regions, Convective-Stratiform Technique.

A new method of estimating both tropical convective precipitation and stratiform precipitation (produced under the anvils of mature and decaying convective systems), denoted CST (Convective-Stratiform Technique) locates, in an array of satellite infrared data, all local minima in the brightness temperature field (Tmin). After an empirical screening to eliminate cirrus, these points are assumed to e convective centers. Rainrate and rain area are assigned to each minimum point as a function of its Tmin, based on one-dimensional cloud model results. A stratiform rain algorithm, using a brightness temperature threshold based on the mode temperature of thunderstorm anvils, completes the convective/stratiform rain estimation. Individual CST rain fields were spatially most similar to the radar for young, isolated storms, and most dissimilar in capturing linear features such as squall lines. Some convective features were missed, while others (generally cirrus debris) were sometimes misrepresented as active convection. Stratiform estimates generally corresponded to the radar-derived 1 mm/hr contour. The technique was tested for four south Florida cases during the second Florida Area Cumulus Experiment (FACE). Half-hourly estimates made in the FACE target area were verified against rain gages and both unadjusted and gage-adjusted radar. When compared to three other infrared techniques applied to the same data set, the CST had the lowest bias (0.02 mm), lowest mean absolute difference (0.28 mm), lowest root mean square difference (0.39 mm), and lowest percent difference (41.2%) of any tested satellite technique. The evolution of the precipitation averaged over the FACE target area (10,000 sq km) was well represented by the CST, particularly in capturing peak rainfall and the transition from convective to stratiform rain. Other satellite schemes tested had a tendency to underestimate the rainfall early and overestimate late, when compared to the gage-adjusted radar. Area-averaged stratiform estimates were in agreement with radar-based analyses and comprised 10-30% of the total rainfall. (Author's abstract)
W88-09534

EVAPORATION OF RAIN FALLING FROM CONVECTIVE CLOUDS AS DERIVED FROM RADAR MEASUREMENTS,
Hebrew Univ. of Jerusalem (Israel). Dept. of Atmospheric Sciences.
D. Rosenfeld, and Y. Mintz.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 3, p 209-215, March 1988. 4 fig, 17 ref. National Science Foundation Grant AMT-8309767 and NASA Grant NAG5-383.

Descriptors: *Precipitation, *Rainfall, *Remote sensing, *Radar, *Evaporation, Weather satellites, Semiarid regions, Rain intensity, Clouds, Africa.

The rainshafts of about 3000 summer afternoon convective rain cells in the semiarid region of central south Africa were tracked and measured with a volume scanning radar. The area and time integrated rain volume of each individual rain cell was obtained at the cloud base level and at a lower level assuming a fixed radar reflectivity-rain intensity relationship. The ratio of the rain volumes at the two levels and, thereby, the cumulative fractional evaporation of the falling rain was found to depend on the rain intensity at the cloud base level and on the fall distance from the cloud base. With a small lifetime peak rain intensity at the cloud base (1.0 mm/hr), about 50% of the rain evaporated by 1 km below the cloud base and all of the rain evaporated by 1.6 km. With a medium rain intensity (10 mm/hr), about 25% evaporated by 1 km and 50% by 1.6 km. With very heavy rain intensity (80 mm/hr), about 15% evaporated by 1 km and 30% by 1.6 km below the cloud base level. These must be regarded as lower limits of the evaporation, because the more rapid evaporational depletion of the smaller drops with increasing fall distance causes a relative radar overestimate of the rain intensity at the lower level and, therefore, an un-

derestimate of the evaporation, when using the vertically fixed radar reflectivity-rain intensity relationship. (Author's abstract)
W88-09535

1 AUGUST 1981 CCOPE STORM: OBSERVATIONS AND MODELING RESULTS,
South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences.
R. J. Kubesh, D. J. Musil, R. D. Farley, and H. D. Orville.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 3, p 216-243, March 1988. 24 fig, 27 ref. National Science Foundation Grants ATM-8311145, ATM-8311548, ATM-8603308, and ATM-8612385.

Descriptors: *Precipitation, *Data collections, *Storms, *Rainfall, Model studies, Cooperative Convective Precipitation Experiment, Montana, Hail.

Observations made by the T-28 armored research aircraft, radar, and other data sources were used to study an eastern Montana hailstorm that developed on 1 August 1981 during the Cooperative Convective Precipitation Experiment season. The storm featured a wide, persistent, vertically oriented updraft with speeds exceeding 35 m/sec. Hailstones of over 5 cm diameter were collected at the ground, while the T-28 encountered hail up to about 2.5 cm diameter. There was no evidence of feeder cells or a weak echo region. The IAS (Institute of Atmospheric Sciences) two-dimensional, time-dependent bulk water model was run on this case, using a sounding from this day. Some areas of agreement between the simulation and observations include the maximum updraft speed, cloud top height, presence of a rounded cloud dome, and maximum radar reflectivity. The simulation failed to model the width and orientation of the updraft properly, as well as its long lifetime. The IAS hail category model was also run on this case. This model features 20 categories of ice particles, which aid in exploring the complexities of hailstone growth. This simulation was dynamically similar to the bulk water simulation. The model predictions of ice particle concentrations agreed fairly well with those observed, and the shedding of drops during the wet growth of hail was a significant source of hail embryos. (Author's abstract)
W88-09536

SAMPLING VARIATIONS OF HAILSTONE SIZE DISTRIBUTIONS,
Alberta Research Council, Edmonton. Resource Technologies Dept.
R. K. W. Wong, N. Chidambaram, L. Cheng, and M. English.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 3, p 254-260, March 1988. 5 fig, 2 tab, 15 ref.

Descriptors: *Meteorologic data, *Precipitation, *Data collections, *Hail, *Storms, *Sampling, Alberta, Statistics.

The use of a shifted gamma size distribution for hailstone samples provided a better fit than the usual exponential form, using time-resolved Alberta data. It is also concluded that there is a dependence of the shape of hailstone size distributions on the duration of sampling time. Such shape variations are associated with the sampling efficiency of the smaller size categories. The importance of the smaller sizes to the common hail integral estimates was also investigated. The minimum sizes required for sampling accuracy of these integral estimates was also obtained. (Author's abstract)
W88-09537

SUMMARY OF THE GLOBAL WEATHER EXPERIMENT WORKSHOPS ON THE HYDROLOGICAL CYCLE AND DATA ASSIMILATION,
Utah Univ., Salt Lake City. Dept. of Meteorology.
For primary bibliographic entry see Field 2A.
W88-09561

CONCENTRATIONS OF DIOXINS AND DIBENZOFURANS IN THE ATMOSPHERE,
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 5B.
W88-09570

FOREST DAMAGE: CHARACTERIZATION OF SPRUCE NEEDLES BY PYROLYSIS FIELD IONIZATION MASS SPECTROMETRY,
Fachhochschule Fresenius, Wiesbaden (Germany, F.R.). Dept. of Trace Analysis.
For primary bibliographic entry see Field 5C.
W88-09572

STABILITY OF PRECIPITATION SAMPLES UNDER FIELD CONDITIONS,
Netherlands Energy Research Foundation ECN, Petten.
For primary bibliographic entry see Field 7B.
W88-09582

SUMMARY OF WEATHER PATTERN DEVELOPMENTS OF THE STORM OF 15/16 OCTOBER 1987,
Meteorological Office, Bracknell (England).
A. Woodroffe.
Meteorological Magazine MTMGA5, Vol. 117, No. 1389, p 99-103, April 1988. 7 fig.

Descriptors: *Meteorology, *Precipitation, *Storms, *Weather patterns, Weather data collections, Weather forecasting, United Kingdom, Bay of Biscay, Iberian Peninsula, Data interpretation, Satellite technology.

A descriptive account is given of the development of the storm of 15/16 October 1987, incorporating analyses of the surface pressure pattern prepared 'after the event' using all available data. The analyses reveal a complex evolution with a series of relatively innocuous low centers running northeastwards across the Bay of Biscay before the arrival of the final low which developed into the major storm. Tracking of the center depicted on the Central Forecasting Office operational analyses suggests slow northeastward transference of the low across the southern Bay of Biscay up to 1800 GMT on 15 October, followed by a rapid acceleration towards the United Kingdom. In reality it was different low centers which were being followed and this explains the inconsistent movement. In contrast the deduced track and depth of the developing low center present a very coherent pattern, with steady deepening of the center as it tracked from west of Iberia to the western English Channel. However, it must be recognized that, even now, some doubt still exists concerning the precise details of the analyses, depending as they do on subjective interpretation of the satellite imagery and the assessment of the reliability of the various ship reports. (Shidler-PTT)
W88-09647

GUIDANCE AVAILABLE AT BRACKNELL FOR THE STORM OF 15/16 OCTOBER 1987, AND THE FORECASTERS' CONCLUSIONS AT THE TIME,
Meteorological Office, Bracknell (England).
A. J. Gadd, and R. M. Morris.
Meteorological Magazine MTMGA5, Vol. 117, No. 1389, p 110-117, April 1988. 5 fig, 1 tab.

Descriptors: *Storms, *Meteorology, *Weather forecasting, *Weather data collections, *Mathematical models, Precipitation, Prediction, Charts, Communication, Public policy, Synoptic analysis, Rainfall intensity, Flooding, Weather patterns, Wind, United Kingdom.

The numerical weather prediction guidance available to forecasters at Bracknell during the period leading up to the storm is reviewed. Forecasters in the Central Forecasting Office (CFO) at Bracknell are provided routinely with guidance from the following numerical weather prediction models: (a) the UK fine-mesh regional model, (b) the UK global model, (c) the European Center for Medium-Range Weather Forecasts model, and (d) the US global model. The steps by which the forecasters reached their conclusions are explained. The Senior Forecaster in CFO is responsible for the issue of centralized guidance to all public service forecast offices throughout the country. In association with the subjectively drawn 24-hour surface forecast chart referred to above, the Senior Forecaster issues a descriptive textual guidance routinely four times daily, although updates and amendments can be issued at any time. Although outstations are required to follow the central guidance, the procedures involved in formulating the guidance include conferences and discussions with all the regional main meteorological offices at least twice daily and more frequently with the national television and radio presenters. The early-morning synoptic reviews were chiefly concerned with the likelihood of heavy rain in the south in view of recent flooding. The Senior Forecaster was also considering yet another solution throughout the day. The fine-mesh solution based on 1200 GMT data on 15 October showed the expected slight changes of track and speed of the wave, but there was no sign of rapid development or of the formation of an occlusion. The synoptic review issued at 1750 GMT mentioned the possibility of rapid deepening of the surface circulation in the next few hours but with no specific mention of winds. The complexity of the developments which exercised the Senior Forecasters' minds throughout the 15th are well revealed in the full text of the synoptic reviews. (Shidler-PTT)
W88-09648

NUMERICAL FORECAST STUDIES OF THE OCTOBER 1987 STORM OVER SOUTHERN ENGLAND,
Meteorological Office, Bracknell (England).
A. C. Lorenc, R. S. Bell, T. Davies, and G. J. Shutts.
Meteorological Magazine MTMGA5, Vol. 117, No. 1389, p 118-130, April 1988. 8 fig, 2 tab, 5 ref.

Descriptors: *Meteorology, *Storms, *Data Interpretation, *Numerical analysis, *Model studies, *Weather forecasting, Weather patterns, Meteorological data collection, United Kingdom, Precipitation.

The dynamical structure of the storm is described with the aid of numerical analyses and forecasts. Causes of differences between operational forecasts are investigated. Excellent 24-hour forecasts with the fine-mesh model were obtained in experiments using observations which arrived after the operational cutoff. There were insufficient observations to define the detailed structure of the developing system at 1200 GMT on 15 October. However, an excellent forecast from this time was obtained using a new assimilation scheme designed to cause less diruption to the forecast model's structure. (Author's abstract)
W88-09649

MAXIMAL DISCHARGES OBSERVED IN ISRAEL,
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 2A.
W88-09701

SALT ACCUMULATION IN THE LOESSIAL SEQUENCE IN THE BE'ER SHEVA BASIN, ISRAEL,
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
M. Magaritz, H. Gvirtzman, and A. Nadler.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 27-33, February 1988. 2 fig, 1 tab, 17 ref.

Descriptors: *Paleoclimatology, *Paleosols, *Leaching, *Sedimentation, *Sediments, Salt accumulation, Loess, Israel, Surface sediments, Accumulation, Salts, Groundwater, Climatic data, Climatology, Arid zone.

Evidence of climatic changes is recorded in the salt content of the surface sediments in arid zones.

In wetter periods airborne salts are removed downward by leaching to the groundwater, whereas in drier periods they accumulate. The period of salt accumulation in the loessial sediments of the northern Negev is about 10,000 years. This period represents the recent aridification phase. The beginning of this stretch of time followed the last humid period in the region. Top paleosol (calcic horizon) found in the region and dated 12,000 yr B.P. is an indicator of this humid period. (Author's abstract)
W88-09702

EXTREME RAINFALL FOR AFRICA AND OTHER DEVELOPING AREAS,
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
G. H. Hargreaves.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 324-333, May 1988. 4 tab, 13 ref, 2 append.

Descriptors: *Rainfall rate, *Depth-area-duration analysis, *Africa, *Developing countries, *Mathematical analysis, *Data collections, *Climatology, Hydrology, Hydraulics, Meteorological data collection.

Adequate and reliable records of rainfall depth-duration-frequency amounts are often not available. Use of estimates of probabilities from limited data can reduce errors due to either underdesign or overdesign of structures and can reduce damage to irrigation facilities and hydraulic structures from floods and excessive runoff. Estimates of extreme rainfall events may also make possible an increased utilization of rain at the locations where it falls. Methods were developed for estimating rainfall intensities with a minimum of data. Equations are given for use with 20-yr return period monthly rainfall amounts and with daily rainfall extremes. Depth-duration and depth-frequency ratios of extreme rainfall amounts have been found to be remarkably uniform within large and diverse geographical areas of Africa. Large expenditures are being made to improve the collection of hydrologic and meteorologic data in the Sahel of Africa. Known ratios and newly developed relationships can improve the use of the existing long records and of data currently being collected. Greater emphasis is being given to training in the use of the climatic data base. (Author's abstract)
W88-09742

OXYGEN ISOTOPIC COMPOSITION AND TEMPERATURE OF FORMATION OF FALLEN SNOW IN ANTARCTICA,
Nagoya Univ. (Japan). Water Research Inst.
For primary bibliographic entry see Field 2C.
W88-09800

PRECIPITATION VARIABILITY OVER THE CARIBBEAN AND TROPICAL AMERICAS ASSOCIATED WITH THE SOUTHERN OSCILLATION,
Ohio State Univ., Columbus. Dept. of Geography.
J. C. Rogers.
Journal of Climate, Vol. 1, No. 2, p 172-182, February 1988. 4 fig, 10 tab, 30 ref. NSF Grant ATM-85-19505.

Descriptors: *Precipitation, *Areal precipitation, *Rainfall distribution, *Climatology, *Tropical regions, *Southern oscillation, Variability, Caribbean Sea, South America, Seasonal distribution, Annual distribution, Subtropic zone, Drought.

Seasonal and annual (July through June) precipitation data for up to 197 stations were used to analyze variability in the High/Dry (H/D) and Low/Wet (L/W or warm-event) modes of the Southern Oscillation (SO) over the tropical Americas and the Caribbean Islands to 30 degrees S latitude. Precipitation was significantly higher during H/D events than during L/W in northern summer, autumn, and winter at most stations in the southern Caribbean and northern South America including the northern Andes and Amazon River basin. Precipitation was significantly higher in L/W than in H/D modes at higher subtropical latitudes of both hemispheres, especially in northern autumn and winter over the southern United States, Cuba, and Mexico, and in spring and autumn over southern Brazil, Paraguay, and Argentina. A similar pattern of spatial precipitation variability occurs in the July-June data and significant H/D minus L/W precipitation differences were found at one-third of the stations. Although drought occurred in Northeast Brazil in some L/W years such as 1982-83, rainfall in other L/W events was above normal, and overall the role of the SO in precipitation variability is not as apparent in Northeast Brazil as it is in northern South America and the Caribbean. (Author's abstract)
W88-09840

INVESTIGATION OF INTERANNUAL RAINFALL VARIABILITY IN AFRICA,
Wisconsin Univ., Madison. Dept. of Meteorology.
J. E. Janowiak.
Journal of Climate, Vol. 1, No. 3, p 240-255, March 1988. 12 fig, 5 tab, 34 ref, append.

Descriptors: *Rainfall, *Rainfall distribution, *Climatology, *Statistical analysis, Temporal distribution, Seasonal variation, Africa, Atlantic Ocean, Tropic zone, Subtropic zone, Southern oscillation, Mathematical analysis.

Interannual variations in African rainfall were examined using rotated principal-component analysis (PCA) applied to anomalies from the annual mean as well as seasonal anomalies. The rotated PCA loading patterns suggest several 'preferred' continental-scale rainfall anomaly patterns. The dominant feature of year-to-year variations in African rainfall appears to be the high spatial coherence of rainfall anomalies over large portions of the continent. In addition, several dipole regions, that is, adjacent regions which tend to experience rainfall anomalies of opposite sign, were found. One dipole region, the sub-Saharan region, appears to have a relationship with a characteristic Atlantic sea-surface temperature anomaly pattern during boreal summer. During austral summer, the tendency for a large-scale dipole pattern in southeast Africa is apparent, as is an association of this pattern with the warm and cold phases of the El Nino/Southern Oscillation (ENSO) phenomenon. Normalized rainfall departures over areas determined from the PCA loading patterns were used as an index from which composites are formed. Patterns of rainfall anomalies, based on composites of high and low values of these indices, were produced to quantify the year-to-year variation in rainfall in the areas studied. During the austral summer of warm-episode ENSO years, rainfall tends to be 10 to 25% above normal east of 20 degrees E between the equator and 10 degrees S and correspondingly lower than normal east of 20 degrees E between 15 and 20 degrees S. The opposite anomaly pattern tends to be observed during cold phases of ENSO in this region. Anomaly dipoles of similar magnitude (when expressed as percentages) tend to be found in sub-Saharan Africa during boreal summer. (Author's abstract)
W88-09841

PREDICTION OF INDIAN MONSOON RAINFALL: FURTHER EXPLORATION,
Wisconsin Univ., Madison. Dept. of Meteorology.
S. Hastenrath.
Journal of Climate, Vol. 1, No. 3, p 298-304, March 1988. 4 fig, 2 tab, 20 ref. NSF Grants ATM-8413575 and ATM-8722410.

Descriptors: *Rainfall forecasting, *Rainfall, *Rainfall distribution, *Monsoons, *Model studies, Prediction, Temporal distribution, Regression analysis, Error analysis, India, Indian Ocean, Atmospheric pressure, Wind velocity, Air circulation.

The predictability of Indian monsoon rainfall anomalies was studied. In addition to the April latitude position of the 500-mb ridge over India, and Darwin pressure tendency, the May surface resultant wind speed in a strategic area of the jet axis over the western equatorial Indian Ocean (0-10 degrees S, 45-50 degrees E) is used as a predictor. Regression models developed on 20-year portions of the 1939-83 record were used to predict the summer monsoon rainfall anomalies of the 25 years from 1959 to 1983. Correlation, root-mean-square error, bias, and absolute error are presented as measures of forecast performance on the 'independent' dataset. It was found that the model constraint optimal for predictive purposes is to be ascertained empirically. 'Updating' is not necessarily superior to the use of a fixed regression base period. Relationships between preseason indicators and monsoon rainfall were strongest in the early and late portions of the 1939-83 record, and weakest in the 1950s and 1960s. Antecedent departures in the large-scale circulation setting allowed prediction of more than 60% of the interannual variance of Indian monsoon rainfall for the period 1959 to 1983, and nearly 80% for 1969 to 1983. (Author's abstract)
W88-09842

NUMERICAL EXPERIMENTS OF CONDITIONAL SYMMETRIC BAROCLINIC INSTABILITY AS A POSSIBLE CAUSE FOR FRONTAL RAINBAND FORMATION PART II. EFFECTS OF WATER VAPOR SUPPLY,
Nagoya Univ. (Japan). Water Research Inst.
S. Saitoh, and H. Tanaka.
Journal of Meteorological Society of Japan JMSJAU, Vol. 66, No. 1, p 39-53, February 1988. 18 fig, 28 ref. Japanese Ministry of Education Grant-in-Aid for Research in Natural Disasters A-61-3.

Descriptors: *Meteorology, *Conditioned symmetric baroclinic instability, *Rainfall, *Weather fronts, *Weather forecasting, *Model studies, Mathematical studies, Prediction, Atmospheric physics, Clouds, Convection, Water vapor, Stratification, Numerical analysis, Troposhere.

A numerical study was conducted of how the low level water vapor supply modifies the circulation of conditional symmetric baroclinic instability (CSBI), and how convective clouds are induced and controlled by CSBI circulation. Three cases of numerical experiment are considered: no water vapor supply, a small water vapor supply, and a large water vapor supply. Developments of clouds, rainfall and stratification are the main features inspected in the three cases. When the water vapor supply is moderate, a slantwise cloud is developed due to the CSBI circulation, as in the case of no water vapor supply. However, nodal convective cells appear embedded in the slantwise cloud. A number of narrow, strong precipitation areas are embedded in the weak and wide-spread precipitation area and are associated with these nodal cells. Convective cells above the slantwise cloud (generating cells) are also developed in the mid-troposphere. When the water vapor supply increases, strong convective clouds rapidly grow at the convergence zone of CSBI circulation and at the slantwise convective unstable layer. The horizontal extension of the rainfall area becomes narrow but the rainfall intensity is greatly enhanced. One of the most important features of the CSBI circulation in rainband formation is to induce the slantwise convective unstable layer, which is appreciably enhanced as the rate of water vapor supply increases. At the same time, an increase of water vapor supply tends to activate cumulus clouds through the combined effect of low level convective unstable layer due to water vapor supply and flow convergence due to CSBI circulation. (Author's abstract)
W88-09865

LARGE-SCALE CLOUD DISTRIBUTIONS AND THEIR SEASONAL VARIATIONS AS DERIVED FROM GMS-IR OBSERVATIONS,
Tokyo Univ. (Japan). Ocean Research Inst.
Y. Kodama, and T. Asai.
Journal of Meteorological Society of Japan JMSJAU, Vol. 66, No. 1, p 87-101, February 1988. 12 fig, 45 ref.

Descriptors: *Infrared imagery, *Weather satellites, *Remote sensing, *Clouds, *Seasonal variation, *Meteorological data collection, *Weather forecasting, Spatial distribution, Mathematical studies, Atmospheric physics, Regional analysis,

Convection, Rainfall, Barometric pressure, Monsoons, Tropic zone, Temperature zone, Comparison studies.

Climatological large-scale features of the cloud distribution and their seasonal variation are investigated using cloudiness data derived from GMS-IR cloud images. The distribution and seasonal variation in cloud-top-height and cloud type (tall convective clouds and stratiform clouds) are investigated by computing a ratio between the amount of high-cloudiness (tops higher than 400mb level) and the amount of high- and middle-cloudiness (tops higher than 700mb level) and by examining the standard deviation of cloud-top-height in 1 deg x 1 deg areas covered with cloud. Results show that the maximum cloudiness is observed in the tropics except east of 150 deg E with a secondary maximum in the mid-latitudes along the cyclone tracks, and the minimum cloudiness is observed around the subtropical highs. The annual mean cloud-top-height between cyclone tracks is observed in both hemispheres; the mean cloud-top-height along the lowest-latitude cyclone tracks is much higher than along the other cyclone tracks. Large annual variations in cloudiness are observed in tropical monsoon areas. In addition, cloud-top-height decreases significantly during the winter over continents and their vicinity for the tropical monsoon areas, which suggests deep convection is strongly suppressed there and active deep convection, which may be enhanced with a cold surge, is restricted to the regions away from the continents during the winter. The decrease of cloud-top-height during the winter is also observed for the region from the southern part of China to Japan. Over the southern part of China and the East China Sea, this large seasonal variation of cloud-top-height is accompanied by a significant seasonal change in cloud type; tall convective clouds in the warm season to stratiform middle-clouds in the cold season. In addition to the tropical and subtropical monsoon areas, tall convective clouds also increase over the Asian Continent even in the higher-latitude to 50 deg N during the summer and high-cloudiness increases. This is significantly different from the fact that high-cloudiness over the Australian Continent is small throughout the year except for the tropical monsoon area. (Author's abstract)
W88-09866

RELATIONSHIPS BETWEEN INDIAN OCEAN SEA SURFACE TEMPERATURE AND THE RAINFALL OF SRI LANKA,
Tsukuba Univ. (Japan). Inst. of Geoscience.
R. Suppiah.
Journal of Meteorological Society of Japan JMSJAU, Vol. 66, No. 1, p 103-111, February 1988. 8 fig, 4 tab, 27 ref.

Descriptors: *Monsoons, *Southern oscillation, *Rainfall, *El Nino, *Pacific Ocean, *Indian Ocean, *Sri Lanka, *Seasonal variation, *Model studies, Mathematical studies, Meteorological data collection, Atmospheric physics, Prediction, Temperature effects, Weather, Spatial distribution, Temporal distribution.

Spatial and temporal variations of the sea surface temperature (SST) over the Indian Ocean are examined by using empirical orthogonal function (EOF) analysis. The first EOF mode explains 20.54% of the total variance indicating positive values which reveal coherent interannual variations over the study area. Time coefficients of the first EOF mode show a strong relationship with Pacific SST anomalies. Therefore, the El Nino/Southern Oscillation (ENSO) events are observed in the time coefficients of the first EOF mode almost simultaneously. Power spectrum analysis reveals a dominant peak ranging from 18 to 48 months which covers the quasi-biennial oscillation (QBO) and the dominant cycle in the Southern Oscillation phenomenon (30 to 40 months). The second and third EOF modes explain relatively less contributions, 5.6% and 5.1% of the total variance. A weak positive correlation coefficient is observed between the time coefficients of the first EOF mode of SST anomalies and the time coefficients of the first EOF mode of the rainfall over Sri Lanka when all months are considered, but strong relationships are noticed for the months of October, November and December which coincide with the mature and decay stages of ENSO events. The positive relationships between SST anomalies of the Pacific and Indian Oceans and rainfall anomalies of the months of October, November and December first appear in March and April, and then gradually build up towards the significant level in the concurrent months. In the case of the summer monsoon season has a significant positive correlation with the SST over the Arabian Sea during the concurrent period, but significant negative correlation with the previous months, before six months. The changes in the sign of the correlation coefficients occur in the months of November-December of the year before the summer monsoon, thus it may be useful to foreshadow the excess and deficit rainfall over Sri Lanka few months in advance. (Author's abstract)
W88-09867

OROGRAPHIC RAINFALL EVENTS IN THE OROFURE MOUNTAIN RANGE IN HOKKAIDO, JAPAN,
Hokkaido Univ., Sapporo (Japan). Dept. of Geophysics.
K. Kikuchi, N. Horie, T. Harimaya, and T. Konno.
Journal of Meteorological Society of Japan JMSJAU, Vol. 66, No. 1, p 125-139, February 1988. 13 fig, 1 tab, 14 ref.

Descriptors: *Orographic precipitation, *Rainfall, *Orofure Mountains, *Model studies, *Simulation, Mathematical studies, Weather forecasting, Wind effects, Rainfall intensity, Prediction, Atmospheric physics, Clouds, Weather, Japan.

The maximum peaks of orographic rainfall are very frequently located on the Orofure Pass, Japan and the Shiraoj Waterfall. It was presumed that when the warm and wet air from the southeast over the Pacific Ocean flowed toward the mountain range, comparatively weak rainfall occurred on the seaside and plains regions owing to the gentle slope, and the heavy rainfall occurred on the mountainous regions owing to the steep slope. The horizontal convergence should increase the rainfall amount on the mountainous regions because the valley became narrower from the seaside to the mountain side. Numerical experiments were carried out to simulate the above prediction. The results of the calculated rainfall taking into account only the forced updraft owing to the mountain slope were smaller than the observed rain in the regions where horizontal convergence appeared to be present. Rainfall computation taking into account both the forced updraft and the horizontal convergence generally coincided with observation. The results show that the greater the precipitation intensity from the upper level clouds, the stronger the rainfall intensity on the mountainous regions and that the greater the wind velocity, the greater the rainfall intensity on the mountainous regions. These findings were compared with the results obtained by the wind velocity. The calculated rainfall intensity on the mountainous regions increased as a function of both the precipitation intensity from the upper level clouds and the wind velocity. If the precipitation intensity from the upper level clouds and the wind velocity on the ground surface can be obtained, the rainfall intensity on the mountainous regions on the southeastern slope of the Orofure mountain range could be predicted using these findings. (Author's abstract)
W88-09868

INTERANNUAL VARIATIONS OF SEA SURFACE TEMPERATURE OVER THE ARABIAN SEA AND THE INDIAN MONSOON: A NEW PERSPECTIVE,
Indian Inst. of Science, Bangalore. Centre for Atmospheric Sciences.
K. G. Rao, and B. N. Goswami.
Monthly Weather Review MRWEAB, Vol. 116, No. 3, p 558-568, March 1988. 11 fig, 1 tab, 33 ref.

Descriptors: *Rainfall, *Water temperature, *Arabian Sea, *Monsoons, *Statistical methods, *India, *Weather forecasting, Weather data collections, Meteorological data collection, Seasonal variation, Model studies, Atmospheric physics, Bay of Bengal, Mathematical studies, Regional analysis, Weather.

The interannual variation of surface fields over the Arabian Sea and Bay of Bengal were studied using data between 1900 and 1979. The monthly mean sea surface temperature (SST) over the north Indian Ocean and monsoon rainfall are significantly affected by synoptic systems and other intraseasonal variations. To highlight the interannual signals it is important to remove the large-amplitude high-frequency noise and very low frequency long-term trends, if any. By suitable spatial and temporal averaging of the SST and the rainfall data and by removing the long-term trend from the SST data, it is shown that there exists a homogeneous region in the southeastern Arabian Sea over which the March-April (MA)SST anomalies are significantly correlated with the seasonal (June-September) rainfall over India. A potential of this premonsoon signal for predicting the seasonal rainfall over India is indicated. It is shown that the correlation between the SST and the seasonal monsoon rainfall goes through a change of sign from significantly positive with premonsoon SST to very small values with SST during the monsoon season and to significantly negative with SST during the post-monsoon months. For the first time, it is demonstrated that heavy or deficient rainfall years are associated with large-scale coherent changes in the SST (although perhaps of small amplitude) over the north Indian Ocean. Possible reasons for the apparent lack of persistence of the premonsoon SST anomalies are given. (Author's abstract)
W88-09870

CUMULUS PARAMETERIZATION AND RAINFALL RATES: PART III,
Florida State Univ., Tallahassee. Dept. of Meteorology.
T. N. Krishnamurti, and H. S. Bedi.
Monthly Weather Review MRWEAB, Vol. 116, No. 3, p 583-599, March 1988. 13 fig, 4 tab, 23 ref.
NSF Grant ATM 83-04809 and NOAA Grant NA 87AA-D-AC038.

Descriptors: *Climatology, *Meteorology, *Rainfall, *Global Atmospheric Research Program, *Meteorological data collection, *Weather forecasting, *Model studies, *Regression analysis, Spatial distribution, Temporal distribution, Seasonal variation, Atmospheric physics, Regional analysis, Prediction, Equations, Weather data collections, Convection, Remote sensing, Tropic zone.

The eastern and western tropical oceans usually show a considerable zonal asymmetry in the extent and depth of deep cumulus convection. Earlier versions of a simple cumulus parameterization based on GATE observations have revealed some limitations in differentiating this type of zonal asymmetry. The aim of the proposed scheme is to provide global statistical corrections to a Kuo-type cumulus parameterization scheme and thus to optimize the moistening, heating and rainfall rates over different regions. The base data for this study are the gridded analyzed first GARP (Global Atmospheric Research Program) global experiment datasets. Three months of daily datasets during the global experiment were used to evaluate the coefficients of a multiple regression analysis. These multiple regression coefficients vary in space and provide different measures of a moistening parameter b and a mesoscale convergence parameter n. A clear distinction in the strength of convection is found, based on the regression parameters, between the western and the eastern oceans. This generalization of modified Kuo-type scheme is derived for a spectral resolution of 42 waves. The impact of the aforementioned scheme is investigated in several medium range prediction experiments. Forecast comparison with a simpler version of the Kuo scheme was carried out also. The results of the global forecasts show a very marked improvement in the short range (1 to 2 day) prediction from the use of the globally varying parameterization coefficients. On the other hand, the precipitation amounts predicted from an application of the local GATE coefficients underestimate the rainfall rates over most regions. (Author's abstract)
W88-09871

ESTIMATES OF THUNDERSTORM PRECIPITATION EFFICIENCY FROM FIELD MEASUREMENTS IN CCOPE,
National Center for Atmospheric Research, Boulder, CO.
J. C. Fankhauser.
Monthly Weather Review MRWEAB, Vol. 116, No. 3, p 663-684, March 1988. 12 fig, 4 tab, 52 ref.

Descriptors: *Precipitation efficiency, *Rainfall, *Cooperative Convective Precipation Experiment, *Thunderstorms, *Remote sensing, *Water vapor, *Weather forecasting, *Meteorological data collection, *Model studies, Mathematical studies, Prediction, Atmospheric physics, Storms, Radar, Wind shear, Hail, Troposphere, Energy.

The precipitation efficiency (the ratio of surface rainfall to water vapor inflow) of a small sample of thunderstorms observed in the Cooperative Convective Precipitation Experiment is calculated using surface and cloud-base airflow and moisture measurements and subcloud rainout based on radar reflectivity factor. Highly-resolved vertical flux measurements from aircraft indicate that a significant amount of water vapor inflow may have been overlooked in past work of this kind, resulting in overestimates in precipitation efficiency. Trends in the mass of water vapor influx resolved at intervals of 10 to 30 min are corroborated by the evolution of water vapor flux convergence computed at 5-min intervals from objectively analyzed surface mesonetwork observations. Fluxes of water vapor inflow and precipitated rainwater are integrated over periods exceeding an hour to obtain precipitation efficiencies applicable to the mature storm phase. Precipitated rainfall estimates from radar reflectivity-rainrate relationships suffer from the usual uncertainties involved in single-parameter radar rainfall estimation, but neither the choice of a particular Z-R relation nor the upper reflectivity threshold assigned to compensate for the likely presence of hail changed the order of the storms when they were ranked according to their precipitation efficiency. This permits a meaningful comparison with environmental factors even though the absolute accuracy of the precipitation efficiency are more complicated than a simple inverse dependence on vertical wind shear, as advanced in earlier work, and that other environmental parameters undoubtedly come into play. In the present analyses, for example, subcloud mixing ration, shear kinetic energy in the lower troposphere and cloud base area all exhibit weak positive correlations with precipitation efficiency, while there was a tendency for storms with high bases to display a slight inverse correlation. (Author's abstract)
W88-09872

STUDY OF KUO-TYPE CUMULUS PARAMETERIZATIONS DURING DIFFERENT EPOCHS OF THE ASIAN SUMMER MONSOON,
Indian Inst. of Tech., New Delhi. Centre for Atmospheric and Fluids Sciences.
S. Das, U. C. Mohanty, and O. P. Sharma.
Monthly Weather Review MRWEAB, Vol. 116, No. 3, p 715-729, March 1988. 8 fig, 6 tab, 17 ref.

Descriptors: *Rainfall, *Monsoons, *Clouds, *Arabian Sea, *Meteorological data collection, *Weather data collections, *Weather forecasting, *Model studies, Mathematical studies, Prediction, Simulation, Atmospheric physics, Comparison studies, Seasonal variation, Regional analysis, Monsoon Experiment-79, Remote sensing, Bay of Bengal.

The performances of several versions of the Kuo-type cumulus parameterization schemes have been examined during different phases of the summer monsoon. These phases are the preonset, an onset and a period of break in the monsoon. Special sets of upper air observations that were collected from stationary ships forming polygons over the Arabian Sea and the Bay of Bengal during MONEX-79 were used for this purpose. Cumulus warming, drying and precipitation rates have been simulated in a semiprognostic way and compared with the observations. The limitations of different schemes for numerical weather prediction are discussed. Among various Kuo-type cumulus parameterization schemes studied in this article, a modified Kuo-scheme is found to provide best results during the summer monsoon. In this scheme the moistening parameter is determined based upon the relative humidity and it is tuned for different phases of the monsoon. A comparison of the performance of various schemes during different phases of the monsoon was made. The heating and drying rates were best simulated during a preonset phase, when compared with the other two periods. The largest deviations between observed and simulated values were obtained during a break in the monsoon. (Author's abstract)
W88-09874

RAINFALL VARIATIONS IN THE GALILEE (ISRAEL): II. VARIATIONS IN THE TEMPORAL DISTRIBUTION BETWEEN 1931-1960 AND 1951-1980,
Haifa Univ. (Israel). Dept. of Geography.
H. Kutiel.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 179-185, May 1988. 5 fig, 2 tab, 7 ref.

Descriptors: *Rainfall, *Seasonal variation, *Temporal distribution, *Spatial distribution, *Weather data collections, *Meteorological data collection, *Climatology, Statistical methods, Israel, Equations, Weather.

Mean monthly rainfalls from different stations in the Galilee (northern Israel) for the periods 1931-1960 and 1951-1980, have been correlated with longitude, latitude and altitude of each station. A seasonal pattern of the explained variance by each of the variables has been found. At the beginning of the rainy season the rainfall is correlated most strongly with the longitude of the stations, during the main rainy season with the altitude and at the end of the rainy season with the latitude of the stations. In the latter period (1951-1980) a retardation of the rainfall regime is observed. A greater portion of the annual total falls during the spring time (March-April) while a parallel decrease in the winter (January-February) rains is observed. The spatial distribution of this retardation and some of its implications are discussed. (Author's abstract)
W88-09923

CHEMICAL NATURE OF ACID PRECIPITATION OVER EUROPE,
Arizona Univ., Tucson. Inst. of Atmospheric Physics.
R. Sequeira.
Current Science, Vol. 56, No. 11, p 514-517, June 1987. 2 fig, 1 tab, 10 ref. NSF Grant ATM-8203509.

Descriptors: *Chemistry of precipitation, *Europe, *Acid rain, *Water chemistry, Statistical methods, Model studies, Data interpretation, Weather data collections, Meteorological data collection, Acidic water, Water pollution sources, Path of pollutants, Climatology, Rainfall, Chemical analysis.

A detailed analysis of the chemical data on wet precipitation for 16 European stations, for the period 1977-1980, was undertaken. The combined pattern of correlation coefficients and the stoichiometric ratios of important chemical species were employed in the interpretation. Trace-to-slight weighted average free acid levels (pH = 5.8-4.7) are found south of about 47 deg N, with the exception of northern Italy. The main acid-neutralizer in this region is alkaline calcium. Moderate or rather high free acid contents exist north of this latitude where the predominant alkali, ammonia, partially neutralizes sulfur acids. The acid precipitation occurring between 47 deg and 55 deg N appears to be associated with the acidic sulfates of ammonium (probably the bisulfate) and/or sulfuric acid. Any role of nitric acid is apparent only to the north of 55 deg N. (Author's abstract)
W88-09954

FACTORS AFFECTING THE IDENTIFICATION OF INDEPENDENT STORM EVENTS,
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
J. V. Bonta, and A. R. Rao.
Journal of Hydrology JHYDA7, Vol. 98, No. 3/4, p 275-293, April 15, 1988. 13 fig, 1 tab, 15 ref.

Descriptors: *Storms, *Precipitation, *Statistical methods, Seasonal variation, Spatial distribution, Data collections, Ohio, Statistical analysis, Variability.

No standard method exists for identifying independent precipitation events for storm-based precipitation events. Two methods using Coshocton, Ohio data are compared in this study the rank correlation and exponential methods, along with an investigation of factors affecting the minimum dry-period duration between storms (termed the critical duration). The exponential method gives higher critical duration estimates than the rank correlation method. The effect of sampling interval of the data collected on critical duration is small for both methods. Consequently, readily available hourly data may be used to estimate the critical duration. Year-to-year, seasonal, and spatial variability in critical duration estimates are found to be great. About ten years of data are required to compute reliable estimates of critical duration. (Author's abstract)
W88-09977

COMPARATIVE STUDY OF AREAL RAINFALL ESTIMATION METHODS USING RAIN GAGE AND RADAR DATA - APPLICATION TO DAILY RAINFALL EVENTS OBSERVED IN THE MONTREAL REGION (ESTIMATION DE LAMES D'EAU SPATIALES A L'AIDE DE DONNES DE PLUVIOMETRES ET DE RADAR METEOROLOGIQUE - APPLICATION AU PAS DE TEMPS JOURNALIER DANS LE REGION DE MONTREAL),
Institut de Mecanique de Grenoble, Saint-Martin d'Heres (France).
G. Delrieu, A. Bellon, and J. D. Creutin.
Journal of Hydrology JHYDA7, Vol. 98, No. 3/4, p 315-344, April 15, 1988.6 fig, 4 tab, 18 ref.

Descriptors: *Rainfall, *Rain Gages, *Rainfall distribution, *Radar, *Data acquisition, Variability, Networks, Remote sensing, Spatial distribution, Montreal, Canada, Kriging.

Several areal rainfall estimation methods using rain gage and weather radar data are reviewed including: (1) Thiessen's and kriging methods relying on rain gage measurements only; (2) the classical cumulative procedure after transformation of reflectivity measurements using a standard Z-R relationship for conventional radar measurements alone; and (3) the uniform calibration method (using a constant multiplicative factor or a nonlinear regression) and the simplified cokriging method for rain gage-radar combinations. An objective procedure based on the definition of reference rainfall depths at ground level and a set of validation criteria is proposed to compare these methods. The methods have been applied to a sample of eleven daily rainfall events in the Montreal area by McGill weather radar data and the Environment Canada rain gage network. The results show that the methods taking into account the spatial variability of rainfall (kriging, simplified cokriging) work much better than more classical approaches. Furthermore, the optimal combination of radar and rain gage information through simplified cokriging leads to better results than each measurement system alone for six out of eleven cases (especially for those presenting high areal variability). (Author's abstract)
W88-09979

2C. Snow, Ice, and Frost

SEASONAL VARIATION IN MARINE PHYTOPLANKTON AND ICE ALGAE AT A SHALLOW ANTARCTIC COASTAL SITE,
For primary bibliographic entry see Field 5C.
W88-09668

OXYGEN ISOTOPIC COMPOSITION AND TEMPERATURE OF FORMATION OF FALLEN SNOW IN ANTARCTICA,
Nagoya Univ. (Japan). Water Research Inst.

K. Kato.
Journal of Earth Science Nagoya University JEASAD, Vol. 35, No. 2, p 355-363, December 1987. 5 fig, 16 ref.

Descriptors: *Snow, *Oxygen isotopes, *Paleohydrology, *Paleoclimatology, *Climatology, Chemistry of precipitation, Antarctic, Temperature of formation, Air temperature, Water vapor.

Taking into consideration the transportation process of water vapor to the Antarctic ice sheet, the correlation between the oxygen isotopic composition and the temperature of formation of fallen snow in Antarctica was investigated. The linear correlation between them shows that fallen snow is formed theoretically by a moist-adiabatic cooling process under equilibrium Rayleigh conditions. The theoretically developed correlation between them is proved by the actual observations. A linear correlation between the monthly means of oxygen isotopic composition of fallen snow and surface air temperature also provides information about the cooling process for its formation. (Author's abstract)
W88-09800

2D. Evaporation and Transpiration

TRITIUM HYDROLOGIC STUDIES IN FOUR CLOSED-BASIN LAKES IN THE GREAT BASIN, U.S.A.,
Lamont-Doherty Geological Observatory, Palisades, NY.
For primary bibliographic entry see Field 7B.
W88-09843

SEASONAL VARIATIONS ON WATER RELATIONS OF AMYGDALUS COMMUNIS L. UNDER DRIP IRRIGATED AND NON-IRRIGATED CONDITIONS,
Centro de Edafologia y Biologia Aplicada del Segura, Murcia (Spain).
For primary bibliographic entry see Field 3F.
W88-09898

EVAPOTRANSPIRATION OF NATIVE VEGETATION IN THE CLOSED BASIN OF THE SAN LUIS VALLEY, COLORADO,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
F. L. Charles, J. A. Morgan, and W. C. Bausch.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-181078/AS. Price codes: A04 in paper copy; A01 in microfiche. Colorado Water Resources Research Institute, Fort Collins, Completion Report No. 143, June 1987. 52 p, 24 fig, 5 tab, 13 ref, append. Contract No. 14-08-0001-G895 and 14-08-0001-G1006. Project No. USGS G895-06 and G1006-06.

Descriptors: *Phreatophytes, *Evapotranspiration, *Groundwater level, *Consumptive use, San Luis Valley, Colorado, Greasewood, Rabbitbrush, Salt grass, Lysimeters.

The Closed Basin project in the San Luis Valley of south-central Colorado is a water salvage project now under construction. Its objective is to pump and salvage water from the unconfined (water table) aquifer which would otherwise be lost through evapotranspiration (ET) The purposes of this research were: (1) to further develop and apply gas analysis technology for measuring ET from native vegetation; (2) to obtain ET measurements on representative plants; (3) to compare these measurements with measurements of ET taken from U.S. Bureau of Reclamation (USBR) lysimeters operating in the same area; and (4) to observe the trends in ET for several different water table depths. Measurements of ET of native vegetation were carried out using the gas analysis chamber method during several periods of 1985 and 1986. Measurements were made of greasewood (Sarcobatus vermiculatus Hook. Torr.), rabbitbrush (Chrysothamnus nauseosus Pall. Britt.), and salt grass (Distichlis stricta L. Greene). These plants constitute the major indigenous vegetation of the closed basin plant community. Both plants showed reduced ET when the water table was lowered below 4.8 meters. There were no substantial differences in the ET of greasewood and rabbitbrush at sites where the groundwater levels have been constant historically at either 1.25 meters (m) or 4.3 meters. Measurements on bare soil indicate a decrease in evaporation with an increase in depth to water table. It was also found that evaporation from bare soil contributes significantly to the total ET of greasewood and rabbitbrush in areas of shallow water table (1.25m). A direct comparison of ET for salt grass measured by gas analysis chamber and lysimeters shows that the lysimeters accounted for only 40 percent of the total salt grass ET measured by the chamber. Measurements covered a period of 77 days. ET measurements on other vegetation at the same site showed similar discrepancies, suggesting problems in the lysimeter data. (USGS)
W88-10032

EVAPOTRANSPIRATION OF PHREATOPHYTES IN THE SAN LUIS VALLEY, COLORADO,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
F. L. Charles.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88 181086/AS. Price codes: A08 in paper copy; A01 in microfiche. Colorado Water Resources Research Institute, Fort Collins, No. 48, June 1987. 107 p, 25 fig, 26 tab, 59 ref, 4 append. (M.S. Thesis) Contract No. 14-08-0001-G895 and 14-08-0001-G1006. Project No. USGS G895-06 and G1006-06.

Descriptors: *Phreatophytes, *Evapotranspiration, *Groundwater level, *Consumptive use, San Luis Valley, Colorado, Greasewood, Rabbitbrush, Salt grass.

The San Luis Valley of south-central Colorado contains a hydrologically closed basin within which a water salvage project has been planned and is partly in operation. This project's goal is to pump water from the unconfined (water table) aquifer which would otherwise be lost through evapotranspiration (ET) from the native rangeland. In order to determine the proper design pumping rate (which will affect subsequent water table drawdown), an accurate estimate of the water use of these plants must be obtained. The basic purposes of this research were: to further develop and apply gas analysis technology for making ET measurements from phreatophytes; to compare these measurements with measurements of ET taken from U.S. Bureau of Reclamation (USBR) lysimeters operating in the same areas: and to observe the trends in ET for several different water table depths and drawdown conditions. Measurement of ET in this area was carried out using the chamber method during several periods of 1985 and 1986. Measurements were made of greasewood (Sarcobatus vermiculatus Hook. Torr.), rabbitbrush (Chrysothamnus nauseosus Pall. Britt.), and salt grass (Distichlis stricta L. Greene) since these plants constitute the major indigenous vegetation of the Closed Basin plant community. At a site of continuous pumping the greasewood plots appeared to suffer a reduction in ET, whereas the rabbitbrush plots exhibited no detectable reduction in ET from the same water table drawdown. There appear to be no substantial differences in the ET of greasewood and rabbitbrush plots between two sites where the groundwater levels have historically been 1.25 meters (m) and 4.3 m. Bare soil evaporation decreased with increasing depth to water table. Bare soil contributes significantly to the total ET of greasewood and rabbitbrush plots in areas of shallow water table (1.25m). A direct comparison shows that the USBR lysimeters accounted for only 40 percent of the mean total salt grass ET measured by the chamber over a period of 77 days. Additional discrepancies in ET measured by the USBR lysimeters and the chamber at the same site indicate possible erroneous estimates of ET by the USBR lysimeters for undisturbed vegetation in the surrounding plant community. (USGS)
W88-10033

FLOW MODEL FOR AN OPEN-CHANNEL REACH OR NETWORK,
Geological Survey, Reston, VA. Water Resources Div.
R. W. Schaffranek.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Professional Paper 1384, 1987. 11 p, 6 fig, 1 tab, 15 ref.

Descriptors: *Model studies, *Open-channel flow, *Network design, *Unsteady flow, *Mathematical models, Flow model, Network simulation, Streamflow forecasting.

Formulation of a one-dimensional model for simulating unsteady flow in a single open-channel reach or in a network of interconnected channels is presented. The model is both general and flexible in that it can be used to simulate a wide range of flow conditions for various channel configurations. It is based on a four-point (box), implicit, finite-difference approximation of the governing nonlinear flow equations with user-definable weighting coefficients to permit varying the solution scheme from box-centered to fully forward. Unique transformation equations are formulated that permit correlation of the unknowns at the extremities of the channels, thereby reducing coefficient matrix and execution time requirements. Discharges and water-surface elevations computed at intermediate locations within a channel are determined following solution of the transformation equations. The matrix of transformation and boundary-condition equations is solved by Gauss elimination using maximum pivot strategy. Two diverse applications of the model are presented to illustrate its broad utility. (USGS)
W88-10069

VAPOR BUDGET MEASUREMENT OF EVAPORATION FROM IRRIGATED SURFACES,
Clemson Univ., SC. Dept. of Civil Engineering.
P. Inmula.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8607360. Ph.D Dissertation, 1985. 100 p, 20 fig, 10 tab, 36 ref, 3 append.

Descriptors: *Vaporization, *Evaporation rate, *Sprinkler irrigation, *Irrigation requirements, *Water vapor, Water resources development, Hydrologic budget, Simulation analysis, Wind velocity, Numerical analysis.

The applicability of the vapor budget technique for the measurement of evaporation was studied to estimate evaporative losses from sprinkler-irrigated areas. Short-term measurements of evaporation were conducted based on the difference in fluxes of atmospheric water vapor. Test observations were made on a simulated irrigated crop area. Simultaneous water budget measurements were made and vapor budget evaporation values were compared with water budget values. The vapor budget was accurate to within about 12% for steady winds when the average of five profile sets was used for each 15 minute evaporation value. The primary advantage of the vapor budget method is that it requires measurements only at the periphery; a disadvantage is that the test results indicate that the consistency of wind direction during observation plays a significant role in the success of the methods. (Cremmins-AEPCO)
W88-10088

2E. Streamflow and Runoff

EFFECTS OF SHORT-TERM AND CONTINUOUS EXPERIMENTAL ACIDIFICATION ON BIOMASS AND PRODUCTIVITY OF RUNNING WATER PERIPHYTIC ALGAE,
Quebec Univ., Montreal. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W88-08963

SIZE-DEPENDENT SENSITIVITY OF THREE SPECIES OF STREAM INVERTEBRATES TO PH DEPRESSION,

Michigan State Univ., East Lansing. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W88-08965

FLUVIAL PROCESSES IN RIVER ENGINEERING,
San Diego State Univ., CA.
H. H. Chang.
John Wiley and Sons, New York. 1988. 432 p.

Descriptors: *River flow, *Channel morphology, *Streamflow, *Fluvial sediments, *Sedimentation, *River mechanics, Geomorphology, Mathematical models, Channels, Catchment areas, Engineering, Hydraulics, Sediment transport, Bank protection.

The subject matter of this book includes river flow, river channel formation, the physical characteristics of rivers, responses of rivers to natural and human-made changes, and analytical methods of design and evaluation. A comprehensive presentation of river processes and engineering must be built upon the foundations of fluvial geomorphology, hydraulics of river flow, and sediment transport. On the basis of this logic, this book is organized into the following five principal parts: Part I - on fluvial geomorphology, presents an overview of the fluvial system, including the river and its drainage basin; Part II - which discusses the physical and analytical foundations of such fluvial processes; (3) Part III - is on regime rivers and responses. While important empirical methods are included in the book, the thrust is on the analytical approach to determine the basic parameters for the hydraulic geometry of alluvial rivers under the dynamic equilibrium and to quantify the fluvial processes of river channel formation and adjustments of equilibrium; (4) Part IV - is devoted to mathematical modeling of alluvial channels, in which modeling techniques and applications are described and illustrated by case studies. The scope is on quasi-two-dimensional modeling to simulate fluvial processes in river channels with a changing boundary; and Part V - on river engineering, is devoted to engineering measures for achieving river training, including bank protection, dikes, grade-control structures, and so on. Each measure is illustrated by examples. (Lantz-PTT)
W88-08990

POTENTIAL CATION LEACHING LOSSES FOLLOWING DISTURBANCE ACROSS A SOUTHEASTERN COASTAL PLAIN LANDSCAPE GRADIENT,
For primary bibliographic entry see Field 4C.
W88-09222

USE OF MULTIPLE STABLE ISOTOPES TO DISCRIMINATE AMONG SOURCES OF ALLOCHTHONOUS ORGANIC MATERIAL,
For primary bibliographic entry see Field 2H.
W88-09223

EFFECTS OF THE 1985 DROUGHT ON BREEDING AND FORAGING ECOLOGY OF WOOD STORKS IN EAST-CENTRAL GEORGIA,
For primary bibliographic entry see Field 2H.
W88-09233

DIGITAL ANALYSIS OF WATER MOVEMENT, WATER QUALITY AND LAND USE EFFECTS IN A STREAM-AQUIFER SYSTEM,
Geological Survey, Tacoma, WA.
J. J. Vaccaro, E. L. Bolke, and J. V. Tracy.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 295-303, 8 fig, 3 tab, 3 ref.

Descriptors: *Washington, *Surface-groundwater relations, *Computer models, *Path of pollutants, *Model studies, *Land use, *Conjunctive use, *Groundwater movement, *Recharge, *Water quality, Rivers, Solute transport, Spokane River, Aquifers, Mass transport, Waste disposal, Chlorides, Septic tanks, Septic wastewater.

The Spokane aquifer, situated in eastern Washington and northwestern Idaho, was designated a sole source aquifer by the EPA. A study was done to quantify the groundwater flow system, to evaluate the amount of selected chemical constituents entering the aquifer from the land surface, and to evaluate the movement of water between the aquifer and the Spokane and Little Spokane Rivers. A coupled fluid flow and mass transport model was constructed, calibrated and operated to estimate a volumetric flow and mass flux budget for the aquifer-river system, which included (1) mass flux of selected chemical constituents from major land surface activities, (2) stream-aquifer flux and mass flux at 233 locations along the Spokane and Little Spokane Rivers, and (3) the impact of domestic, septic waste disposal systems on the groundwater quality of the Spokane aquifer. The 233 locations represent river model node points where river stage, discharge and water quality are calculated. The error in simulated groundwater levels was estimated to be plus or minus 6 ft, and the error in simulated discharges was within the accuracy of the observed values. The conservative ion, chloride, was used as the mass transport modeled species with an error of 14%. The time-averaged budgets computed by the model indicate that subsurface inflow to the aquifer from the boundaries is the dominant recharge mechanism, both chemically and hydrologically. The Little Spokane River and the western (downstream) boundary are approximately constant discharge components of the groundwater system for the period of study. The areas that receive the largest land surface loadings do not always correspond to the observed higher concentration fields. This phenomenon is due to the spatial variability of the discharge per unit aquifer width and of the transmissivity. It was estimated that the impact of septic waste disposal systems, represented by the chloride ion, was <1 mg/liter increase over 80% of the aquifer. The model is a reasonable tool for assessing management decisions that could affect water quality, before they are imposed. (See also W88-09240) (Cassar-PTT)
W88-09273

PALAEOHYDROLOGY IN PRACTICE: A RIVER BASIN ANALYSIS.
For primary bibliographic entry see Field 2A.
W88-09360

INTRODUCTION,
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09361

MODELS FOR PALAEOHYDROLOGY IN PRACTICE,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09362

CONTEMPORARY RIVER: THE BASIN,
University Coll. of Wales, Aberystwyth.
J. Lewin.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 37-48, 3 fig, 3 tab, 37 ref.

Descriptors: *River basin analysis, *Geomorphology, *Severn River, *Wye River, *United Kingdom, *Paleohydrology, History, Stratigraphy, Glaciation, Ice, Geology, Drainage systems.

The morphology, geological evalution and Quaternary stratigraphy of the Severn Basin are reviewed, showing that the basin as a whole provides a highly heterogeneous basis for the subsequent hydrological developments. The changes of the last 15,000 years are in no way as dramatic as those involving drainage diversion and meltwater drainage in the earlier Devensian, while the earlier stages of the Quaternary and the origins of the drainage system itself remain obscure and controversial. It is important to appreciate that such a history has provided so varied a heritage: relief contrasts and a complex cover of superficial deposits must mean that the hydrological response to environmental change in more recent times is one of variety, with a spatial diversity to the evidence available for paleohydrological interpretation. These contrasts lie particularly in relief, as between the higher Welsh plateaux of the West and the lower East; in lithology, with Paleozoic rocks again to the West and in contrast to the Mesozoic cover in the Avon system and underlying the Shropshire plain; and in terms of a Quaternary history during which the area has been affected by having straddled ice-terminal positions on two, and quite possibly more occasions. (See also W88-09360) (Lantz-PTT)
W88-09363

SPATIAL VARIABILITY IN THE CLIMATE OF THE SEVERN BASIN: A PALAEOHYDROLOGICAL PERSPECTIVE,
Birmingham Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09364

PRESENT-DAY HYDROLOGY OF THE RIVER SEVERN,
Severn-Trent Water Authority (England).
T. R. Wood.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 79-97, 11 fig, 12 ref.

Descriptors: *Weather, *Hydrological regime, *Severn River, *United Kingdom, *Paleohydrology, Seasonal variation, Flow patterns, Flow profiles, Flow discharge, Catchment basins, Time series analysis.

The annual flow regime of the Severn is typical of large rivers in temperate climates. The mean discharge is some 10,200 ml/d at Gloucester and the variance is small. The lowest recorded annual discharge at Bewdley is still 60% of the mean. Nevertheless individual monthly mean flows can fall to surprisingly low values. It is possible to calculate the flow which would have occurred without the effect of abstraction of discharge (the so called 'naturalized' flow). Naturalized flows show that without low-flow augmentation by reservoir releases, individual months could be as little as 12% of the mean. Again that statistic is based on Bewdley, which has a high monthly variance for such a large catchment (4274 sq km). As to whether there are any significant changes in the frequency of occurrence of low flows, again the short hydrological record leaves doubt. There is some evidence that UK weather is becoming more variable, with enhanced annual runoff and a tendency to drier summers and wetter autumns. However, this is pattern observed only over the past 10 years and is probably a small perturbation in the long-term cycle of climatic change. Engineering hydrologists might regard paleohydrology as too academic to be of direct use, but it is increasingly clear that historic records should be used to understand the return periods of extreme events - whether they be the return periods of major floods or of droughts. (See also W88-09360) (Lantz-PTT)
W88-09365

CLIMATIC CHANGE OVER THE LAST MILLENIUM IN CENTRAL BRITAIN,
Birmingham Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09366

ENVIRONMENTAL CHANGE AND HYDROLOGICAL RESPONSE: FLOODING IN THE UPPER SEVERN CATCHMENT,
University Coll. of Wales, Aberystwyth. Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09367

HISTORICAL RIVER CHANNEL CHANGES,
University Coll. of Wales, Aberystwyth.
J. Lewin.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 161-175, 8 fig, 1 tab, 17 ref.

Descriptors: *Geomorphology, *Rivers, *Channel morphology, *Paleohydrology, *River channels, *Severn River, *United Kingdom, Flow profiles, Channel flow, History, Hydrologic regime, Flow velocity, Spatial distribution, Temporal distribution.

Historical information on channel change for the Severn River are illustrated both by considering both spatial and the temporal variability, suggesting the value and the limitations of such information both in looking back at an interpretable past and perhaps forward also to a more or less predictable future. The middle reaches of rivers, or the 'piedmont zone', show the greatest degree of channel migration historically. This is broadly interpretable in terms of available streampower and available alluvial valley floor. However, precise relationships between change rate and streampower, or change rate and evolving pattern, are less than satisfactory. Multivariate models are an improvement, but even these are less satisfactory than is desirable. (See also W88-09360) (Lantz-PTT)
W88-09368

MORPHOLOGICAL RESPONSES AND SEDIMENT PATTERNS,
Polytechnic Wolverhampton (England). School of Applied Sciences.
D. J. Mitchell, and A. J. Gerrard.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 177-199, 4 fig, 7 tab, 90 ref.

Descriptors: *Geomorphology, *Rivers, *Severn River, *Wye River, *River morphology, *Sedimentation, *Paleohydrology, Sediment transport, River basins, Catchment areas, Erosion, Hydrologic models, Model studies, Temporal distribution, Stratigraphy, Vegetation, Spatial distribution, United Kingdom.

River basins are complex process-response systems and the larger the basin, the more complex is the system. Concepts such as landscape sensitivity and magnitude and frequency considerations can be applied to small drainage basins and to large drainage basins over short time periods. Increasing the scale of the unit of study increases the complexity and reduces the sensitivity of the system. Thus severe problems are faced when efforts are made to assess morphological responses and changing patterns of erosion, transport and deposition of sediment. The examples reviewed here from the Severn-Wye catchment (United Kingdom) show that the interplay between catchment controls and characteristics and catchment response is far from straightforward, with many potential linkages. It is clear that no single approach will produce a definitive statement of long-term erosion, storage and yield. A stratigraphic analysis of river and slope deposits will enable the broad framework of landscape change to be established. As more efficient models of the relationships between erosion and vegetation type and cover become available, the evidence provided by the stratigraphic approach can be explained in more specific terms. But the 'fine-tuning' can only be achieved by detailed studies of the scale and timing of slope and fluvial activity within basins of differing spatial scales. All three approaches are required for paleohydrology to become an exact study. (See also W88-09360) (Lantz-PTT)
W88-09369

RIVER TERRACES: THE GENERAL MODEL AND A PALEOHYDROLOGICAL AND SEDIMENTOLOGICAL INTERPRETATION OF THE TERRACES OF THE LOWER SEVERN,
University Coll. of Wales, Aberystwyth. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W88-09370

RIVER TERRACES: THE GENERAL MODEL AND A PALEOHYDROLOGICAL AND SEDIMENTOLOGICAL INTERPRETATION OF THE TERRACES OF THE LOWER SEVERN,
University Coll. of Wales, Aberystwyth. Dept. of Geography.
M. R. Dawson, and V. Gardiner.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 269-305, 6 fig, 2 tab, 57 ref. IGCP Project No. 158.

Descriptors: *Geomorphology, *River terraces, *Paleohydrology, *Sedimentology, *Severn River, *Wales, Drainage, Terraces, Model studies, History, Alluvial channels, Rivers, Terrace channels.

River terraces are a fundamental part of fluvial landscapes, and have been valuable to man as sources of natural resources since prehistoric times. Some of the general models which have been advanced to explain river terraces as landforms are examined. The terrace suites of the Severn/Avon systems (United Kingdom) are briefly described, and a sedimentological interpretation of the lower Severn and Avon terraces is offered as a contribution toward their paleohydrological interpretation. Stratigraphy of the Main Terrace and the Worcester Terrace is described and probable prehistoric channel forms at these sites are suggested. The development of the terraces studied was controlled by a complex interaction between channel sediment inputs, discharge and changes in relative base level. Channel planform during the aggradation of both terraces was characterized by low-sinuosity, often braided, channels. The Main Terrace is dominantly composed of gravelly channel-zone sediments, with interbedded coarse gravel and sand deposits locally overlain by alluvial fans, at proximal locations showing a downstream transition to sequences where channel-zone and sandy overbank units are distinctly segrated. Channel planform seems to have remained constant during the formation of the Main Terrace, although a transition to a single-channel planform is likely to have occurred during terrace incision. In contrast, channel planform changed from a gravelly braided channel during the initial aggradation of the Worcester Terrace to a largely sand-bed low-sinuosity channel. Discharges appear to have been greatest during the deglacial period, increasing after the formation of the Main Terrace to a maximum prior to aggradation of the Worcester Terrace. (See also W88-09360) (Lantz-PTT)
W88-09370

LONG-TERM SEDIMENT STORAGE IN THE SEVERN AND WYE CATCHMENTS,
Leicester Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-09371

EVOLUTION OF EUROPEAN RIVERS - A COMPLEX RESPONSE,
Polish Academy of Sciences, Krakow. Dept. of Geomorphology and Hydrology.
L. Starkel.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 333-339, 48 ref.

Descriptors: *Geomorphology, *Paleohydrology, *Human impacts, *Rivers, *Europe, Alluvial rivers, River flow, Ice, Glaciers, Channeling, Tectonics, Agriculture, Quarternary, Soil erosion, Halocene, Dams, Canals.

Paleogeographic changes occurring since the time of the maximum extent of the last ice sheet are evidenced in sediments, morphology and various biotic remains. In a north to south transect across Europe, four main types of river system evolution can be distinguished: (1) River systems recently developed on areas formerly covered by ice sheets and affected by various tectonic movements; (2) River systems of the former periglacial zone, partly influenced by ice sheet; (3) River systems of the former periglacial zone with the lower sections influenced by eustatic sea level changes; and (4) River systems of the former cold steppe and forest-steppe zone, usually deeply influenced by differentiated tectonic movements as well as by early agricultural activities. In the Halocene history of European river valleys the significance of human activity decreases towards the north and east. Neolithic and later phases of deforestation and extensive agriculture caused intensive soil erosion in the south of Europe and the river channels and alluvial plains were totally transformed. These changes came later in western and central Europe and last in eastern Europe. The regulation of rivers and the construction of dams and canals led to partial or total change in the natural hydrologic regime. (See also W88-09360) (Lantz-PTT)
W88-09372

HISTORY OF HYDROLOGY.
For primary bibliographic entry see Field 2A.
W88-09405

HISTORY OF PALEOFLOOD HYDROLOGY IN THE UNITED STATES, 1800-1970,
Cascades Volcano Observatory, Vancouver, WA.
J. E. Costa.
IN: The History of Hydrology. American Geophysical Union, Washington, DC. 1987. p 49-53, 35 ref.

Descriptors: *United States, *Geophysics, *Paleohydrology, *Floods, *Rivers, *Erosion, *Sediment transport, *History, Scabland, Fluvial sediments, Alluvial deposits, Glacial drift, Sediments, Vegetation, Trees, Flood plains, Missoula Flood, Geological terraces, Pleistocene.

The origins of paleoflood hydrology in the United States can be traced to the early 19th century, when windgaps and watergaps in the Appalachians were believed to have been eroded by extraordinary floods caused by rapid drainage of large lakes impounded behind the mountain ridges. Sediment evidence for extraordinary floods was evoked several decades later when glacial sediments in New England were interpreted as deposits from the great Biblical deluge, and estimates of the depth and velocity of the great flood were attempted. The popularization of the glacial origins of drift by Agassiz by 1840 resulted in strong beliefs in uniformitarianism and waning interests in paleoflood investigations. In the early 1920s Bretz attributed the origins of the channeled scablands of eastern Washington to catastrophic glacial outbreak floods. This renewed interest in paleoflood hydrology. Subsequent efforts to reconstruct hydraulic variables of past floods used conventional open channel flow equations applied to other enormous Pleistocene floods. The elevation of sediments was used as a paleostage estimator in the 1880s. Examples were the glacial melting in the Connecticut River valley, which produced an enormous flood of 43 m maximum stage and the 1936 and 1938 floods in the same valley which were the highest since 2500-6000 years ago. Botanical techniques for flood estimation were well documented by the mid 1960s. Examples included the Little River Valley, Virginia, flood of 1949, in which hemlocks were damaged that had not been flooded for over 150 years. It was also discovered that evidence on trees growing in flood plains yielded information on flood stage: scar patterns, direction of sprout growth, and level of stem wood vs. root wood. The movement of large boulders in the 1968 Truckee River (California-Nevada) was used to calculate flood conditions experienced in the 1968 flood. (See also W88-09405) (Cassar-PTT)
W88-09407

MEASURING THE RIVERS OF THE PAST: A HISTORY OF FLUVIAL PALEOHYDROLOGY,
Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.
P. C. Patton.
IN: The History of Hydrology. American Geophysical Union, Washington, DC. 1987. p 55-67, 7 fig, 101 ref.

Descriptors: *Geophysics, *Rivers, *Paleohydrology, *Floods, *Erosion, *Literature reviews, History, Flood frequency, Hydrology, Sediment transport, Missoula Flood, Flood plains, Meanders, Bankfull stage, River morphology, Geological ter-

races, Braided streams, Scabland, Alluvial deposits, Fluvial sediments, Glacial drift.

Fluvial paleohydrology, the study of the long-term hydrologic behavior of ancient and modern rivers, has historically been approached in two ways. The first approach concerns the hydrologic conditions that existed during the formation of ancestral streams. The evolution of this paleohydrological approach is directly linked to the evolution of theories concerning the origin of the fluvial landscape. Hydrologic reconstructions are based on the morphology and sedimentology of paleochannels and the analogy to modern rivers. The reconstructions result in estimates of relatively high frequency stream discharge, such as bankfull discharge. These data, with other paleoenvironmental indices, assist in the definition of the paleoclimate at the time of channel formation and the magnitude of past hydrologic fluctuations. A second paleohydrologic approach concerns discrete hydrologic events, usually high-magnitude floods. Paleoflood hydrology involves attempts to reconstruct the magnitude and frequency of rare great floods from stratigraphic evidence. The study of paleoflood hydrology can be traced to the pioneering work of J. Harlen Bretz, who made the first comprehensive analysis of a paleoflood, the Late Pleistocene catastrophic flood of the Channeled Scabland in eastern Washington. Paleoflood data can be related to modern rivers in order to construct long flood frequency records that can provide insight into the frequency of extreme hydrologic events within a climate or range of climates. (See also W88-09405) (Author's abstract)
W88-09408

RIVER AND STREAM RESTORATION,
Tulsa Univ., OK. Faculty of Biological Science.
For primary bibliographic entry see Field 5G.
W88-09450

MODELS OF SORPTIVE TOXIC SUBSTANCES IN FRESHWATER SYSTEMS: III. STREAMS AND RIVERS,
Manhattan Coll., Bronx, NY. Dept. of Environmental Engineering and Science.
For primary bibliographic entry see Field 5B.
W88-09524

EFFECTIVE DISCHARGE FOR SUSPENDED SEDIMENT TRANSPORT IN STREAMS OF THE SASKATCHEWAN RIVER BASIN,
Saskatchewan Univ., Saskatoon. Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-09544

PERFORMANCE OF THE TWO-COMPONENT EXTREME VALUE DISTRIBUTION IN REGIONAL FLOOD FREQUENCY ANALYSIS,
Geological Survey, Lakewood, CO.
N. W. Arnell, and S. Gabriele.
Water Resources Research WRERAO, Vol. 24, No. 6, p 879-887, June 1988. 2 fig, 9 tab, 18 ref.

Descriptors: *Extreme value analysis, *Regional analysis, *Rivers, *Flood frequency, Two-component extreme value estimation, Regression analysis, Mathematical analysis, Estimating equations.

The performance of the regional two-component extreme value (TCEV) estimation procedure in estimating both dimensionless regional frequency curves showing the T-year flood as a multiple of the mean annual flood and site curves incorporating local and regional information was assessed using computer simulation experiments. It was found that the TCEV procedure produced estimates of both dimensionless regional curves and scaled site quantiles that were relatively unbiased but very variable when data were drawn from TCEV or Wakeby parents, although estimates were very biased when data followed a GEV distribution. The TCEV procedure was robust in the sense that its worst efforts were less bad than those of the alternatives considered, but performance declined significantly as sample sizes reduced. (Author's abstract)
W88-09545

ORGANIC CONTAMINANTS IN ADULT AQUATIC INSECTS OF THE ST. CLAIR AND DETROIT RIVERS, ONTARIO, CANADA,
Windsor Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W88-09548

FACTORS AFFECTING METAL PARTITIONING DURING RESUSPENSION OF SEDIMENTS FROM THE DETROIT RIVER,
Clarkson Univ., Potsdam, NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W88-09555

ZONATION OF MAYFLY NYMPHS AND CADDISFLY LARVAE IN THE ST. MARYS RIVER,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
For primary bibliographic entry see Field 5C.
W88-09556

EFFECTS OF FLOODING AND SEDIMENTS ON THE STRUCTURE OF A STREAM MIDGE ASSEMBLAGE,
Ohio Univ., Athens.
For primary bibliographic entry see Field 2H.
W88-09619

USE OF PREDICTION TO ASSESS MACROINVERTEBRATE RESPONSE TO RIVER REGULATION,
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 2H.
W88-09621

EFFECTS OF EXPERIMENTAL ACIDIFICATION ON A LOTIC MACROINVERTEBRATE COMMUNITY,
Laval Univ., Quebec. Dept. de Biologie.
For primary bibliographic entry see Field 5C.
W88-09622

AQUATIC OLIGOCHAETA IN SOME TRIBUTARIES OF THE RIO DE LA PLATA, BUENOS AIRES, ARGENTINA,
Universidad Nacional de La Plata (Argentina). Inst. de Embriologia.
For primary bibliographic entry see Field 5C.
W88-09626

FRESH WATERS OF SHETLAND: CHEMICAL CHARACTERISTICS OF RUNNING WATERS,
Institute of Terrestrial Ecology, Edinburgh (Scotland).
For primary bibliographic entry see Field 2K.
W88-09629

MACROINVERTEBRATE DRIFT IN A ROCKY MOUNTAIN STREAM,
Maryland Univ., College Park. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W88-09632

EFFECT OF SALMON REDD EXCAVATION ON STREAM SUBSTRATE AND BENTHIC COMMUNITY OF TWO SALMON SPAWNING STREAMS IN CANTERBURY, NEW ZEALAND,
Ministry of Agriculture and Fisheries, Christchurch (New Zealand). Fisheries Research Div.
For primary bibliographic entry see Field 2H.
W88-09635

DISSOLVED ORGANIC CARBON IN STREAMS AND GROUNDWATER,
Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 2K.
W88-09636

EFFECTS OF PHYSICAL DISTURBANCE AND CANOPY COVER ON ATTACHED DIATOM COMMUNITY STRUCTURE IN AN IDAHO STREAM,
Idaho State Univ., Pocatello. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W88-09637

PARTICULATE ORGANIC MATTER IN A MOUNTAIN STREAM IN THE SOUTH-WESTERN CAPE, SOUTH AFRICA,
Cape Town Univ. (South Africa). Dept. of Zoology.
J. M. King, J. A. Day, B. R. Davies, and M.-P. Henshall-Howard.
Hydrobiologia HYDRB8, Vol. 154, p 165-187, November 16, 1987. 7 fig, 10 tab, 54 ref.

Descriptors: *Nutrients, *Streams, *Particulate matter, *Organic matter, *Detritus, *Alpine regions, Leaves, Stream discharge, Calorimetry, Carbon, Nitrogen, Annual distribution, Seasonal distribution, South Africa, Benthic environment, Perennial streams, Riparian Vegetation, Streambeds, Scour, Particle size, Stream erosion, Streamflow, Chemical properties.

The quality and quantity of allochthonous inputs and of benthic organic matter were investigated in a second-order, perennial mountain stream in the south-west Cape between April 1983 and January 1986. Although the endemic, riparian vegetation is sclerophyllous, low, and evergreen, inputs of allochthonous detritus to the stream (434 to 500 g per square m per y) were similar to those recorded for riparian communities worldwide, as were calorific values of these inputs (9548 to 10,032 KJ per square m per y). Leaf fall of the riparian vegetation is seasonal, occurring in spring (November) as discharge decreases, resulting in retention of benthic organic matter (BOM) on the stream bed during summer and early autumn (maximum 224 g per square m). Early winter rains (May) scoured the stream almost clean of benthic detritus (winter minimum 8 g per square m). Therefore, BOM was predictably plentiful for about half of each year and predictably scarce for the other half. Coarse BOM (CBOM) and fine BOM (FBOM) constituted 46-64% of BOM standing stock, ultra-fine BOM (UBOM) 16-33% and leaf packs 13-24%. The mean annual calorific value of total BOM standing stock was 1709 KJ per square m. Both standing stocks and total calorific values of BOM were lower than those reported for streams in other biogeographical regions. Values of C:N ratios decreased with decrease in BOM particle size (CBOM 27-100; FBOM 25-27; UBOM 13-19) with no seasonal trends. The stream is erosive with a poor ability to retain organic detritus. Its character appears to be dictated by abiotic factors, the most important of which is winter spates. (Author's abstract)
W88-09642

DISTRIBUTION OF FRESHWATER SNAILS IN THE RIVER NIGER BASIN IN MALI WITH SPECIAL REFERENCE TO THE INTERMEDIATE HOSTS OF SCHISTOSOMES,
Danish Bilharziasis Lab., Charlottenlund.
For primary bibliographic entry see Field 5B.
W88-09670

PROTOZOAN COMMUNITIES OF THE FLINT RIVER - LAKE BLACKSHEAR ECOSYSTEM (GEORGIA, USA),
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 2H.
W88-09675

ROLE OF GROUNDWATER IN THE IMPACT OF CLIMATE WARMING ON STREAM SALMONINES,
Toronto Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 2F.
W88-09677

LONGITUDINAL DISTRIBUTION OF RIVERINE BENTHOS: A RIVER DIS-CONTINUUM,
Minnesota Univ., St. Paul. Dept. of Forest Resources.
For primary bibliographic entry see Field 2H.
W88-09681

MACRO-INVERTEBRATE COMMUNITIES OF TEMPORARY POOLS IN AN INTERMITTENT STREAM IN TROPICAL QUEENSLAND,
James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W88-09686

INFLUENCES OF HABITAT AND SEASONAL SAMPLING REGIMES ON THE ORDINATION AND CLASSIFICATION OF MACROINVERTEBRATE ASSEMBLAGES IN THE CATCHMENT OF THE RIVER WYE, WALES,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 7C.
W88-09690

FRESHWATER MUSSELS (UNIONIDAE) OF THE UPPER OHIO RIVER, GREENUP AND BELLEVILLE POOLS, WEST VIRGINIA,
West Virginia Dept. of Natural Resources, Charleston. Div. of Water Resources.
For primary bibliographic entry see Field 2H.
W88-09700

MAXIMAL DISCHARGES OBSERVED IN ISRAEL,
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 2A.
W88-09701

NITRATE ENHANCEMENT OF NITRIFICATION DEPTH IN SEDIMENT/WATER MICROCOSMS,
Oxford Univ. (England). Soil Science Lab.
For primary bibliographic entry see Field 5B.
W88-09706

VARIABILITY OF THE METAL CONTENT OF FLOOD DEPOSITS,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W88-09707

SHEAR STRESS VARIATIONS IN AN ESTUARY,
Imperial Chemical Industries Ltd., Brixham (England). Brixham Lab.
For primary bibliographic entry see Field 2L.
W88-09712

MODIFICATION OF TEMPERATURE BEHAVIOUR THROUGH REGULATION OF A BRITISH RIVER SYSTEM,
Exeter Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 4A.
W88-09721

ACCUMULATION OF FINE SEDIMENT WITHIN SUBSTRATE GRAVELS ALONG TWO REGULATED RIVERS, UK,
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 6G.
W88-09724

IMPORTANCE OF STREAMLINING IN INFLUENCING FISH COMMUNITY STRUCTURE IN CHANNELIZED AND UNCHANNELIZED REACHES OF A PRAIRIE STREAM,
Iowa State Univ., Ames. Dept. of Animal Ecology.
For primary bibliographic entry see Field 6G.
W88-09725

NOTE ON THE PROBLEM OF USING BIOLOGICAL SURVEYS TO ASSESS WATER QUALITY IN SMALL ALPINE TORRENTS,
Milan Univ. (Italy). Ist. di Biologia.
For primary bibliographic entry see Field 5A.
W88-09727

HISTORICAL CHANGES OF A LARGE RIVER IN AN URBAN AREA: THE GARONNE RIVER, TOULOUSE, FRANCE,
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
For primary bibliographic entry see Field 4C.
W88-09728

FLOOD ALLEVIATION OF THE KAKEHASHI BASIN, JAPAN,
Kanazawa Inst. of Tech. (Japan). Dept. of Mechanical System Engineering.
For primary bibliographic entry see Field 4A.
W88-09729

ASSESSING IMPACTS OF IRRIGATION ON STREAMFLOW,
Michigan State Univ., East Lansing. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 3F.
W88-09733

VENTURI FLUME OF MINIMUM SPACE REQUIREMENTS,
Ecole Polytechnique Federale de Lausanne (Switzerland). Chaire de Constructions Hydraulics.
For primary bibliographic entry see Field 7B.
W88-09734

FLOOD SKEW IN HYDROLOGIC DESIGN ON UNGAGED WATERSHEDS,
Maryland Univ., College Park. Dept. of Civil Engineering.
R. H. McCuen, and T. V. Hromadka.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 301-310, May 1988. 2 tab, 12 ref.

Descriptors: *Statistics, *Skew, *Flood peak, *Watersheds, *Design criteria, *Flood frequency, Hydraulics, Mathematical analysis, Water storage, Prediction equations, Channel storage, Storage.

The skew of a peak-discharge frequency curve is an important determinant of the magnitude of events having small exceedance probabilities. Methods for estimating skews for ungaged locations provide highly inaccurate estimates. This appears to be the result of a lack of understanding of the primary causes of variation in skew. An analysis of existing hydrologic methods indicates that the skew assumed with these methods for ungaged locations is different than the mean skew for gaged sites in the same area. Furthermore, the design methods suggest that watershed storage is the primary factor affecting skew, with an increase in skew as the volume of watershed storage is decreased. Variables that show greater potential for providing accurate estimates of skew include percentage of imperviousness, presence of flood control structures, and rainfall. A relationship for estimating the effect of imperviousness on skew is provided. (Hammond-PTT)
W88-09740

SEASONAL PATTERNS OF SUSPENDED BACTERIA AND ALGAE IN TWO NORTHERN CALIFORNIA STREAMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W88-09748

RELATIONSHIP BETWEEN ALGAL DRIFT, DISCHARGE AND STREAM ORDER IN A BOREAL FOREST WATERSHED,
National Museum of Natural Sciences, Ottawa (Ontario). Botany Div.
For primary bibliographic entry see Field 2H.
W88-09751

PRELIMINARY OBSERVATIONS ON PRIMARY PRODUCTIVITY AND PHYTOPLANKTON ASSOCIATIONS IN THE VAAL RIVER AT BALKFONTEIN, SOUTH AFRICA,
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W88-09758

IMPACT ON THE SENJOGAHARA ECOSYSTEM OF EXTREME RUN-OFF EVENTS FROM THE RIVER SAKASAGAWA, NIKKO NATIONAL PARK: II. THE CORRELATION OF VEGETATION AND ENVIRONMENTAL DISTURBANCE USING TWINSPAN AND DCA ORDINATION TECHNIQUES,
Tokyo Univ. of Agriculture and Technology (Japan). Faculty of Agriculture.
T. Huskusima, K. A. Kershaw, and J. H. Looney.
Ecological Research, Vol. 2, No. 1, p 85-96, April 1987. 4 fig, 3 tab, 13 ref.

Descriptors: *Floods, *Vegetation, *Statistical methods, *Ecosystems, *Wetlands, *Multivariate analysis, *Flood damage, TWINSPAN, Detrended correspondence analysis, Senjogahara Moor, Classification, Mathematical analysis, River Sakasagawa, Japan, Spatial distribution, Time series analysis, Erosion, Deposition.

Vegetational data from Senjogahara Moor, Nikko National Park, Japan, have been analyzed using two contrasting but parallel multivariate approaches as a basis for future studies. The plant communities objectively defined using a divisive polythetic classificatory approach (TWINSPAN) have been successfully overlayed on an ordination of the same data using detrended correspondence analysis (DCA). The results reveal a vegetational mosaic reflecting differential levels of flood damage to the vegetation and its subsequent rates of recovery, in a space-time continuum. The results from TWINSPAN classification show that 13 plant communities are present in the sample area and these correlate closely with complete absence, slight, or extremely heavy disturbance. The form of the disturbance as either channel erosion or alluvial depositional features also corresponds quite closely with the vegetational types and is reflected in the ordination axes derived from DCA. (Author's abstract)
W88-09771

LIMNOLOGICAL CHARACTERISTICS OF THE AREAS OF CAPTURE OF 'MANJUBA' ANCHOVIELLA LEPIDENTOSTOLE (FOWLER, 1911) (OSTEICHTHYES, ENGRAULIDAE), IN RIBEIRA DE IGUAPE RIVER FROM REGISTRO (SP) (CARACTERISTICAS LIMNOLOGICAS DE AREAS DE CAPTURA DE MANJUBA ANCHOVIELLA LEPIDENTOSTOLE (FOWLER, 1911) (OSTEICHTHYES, ENGRAULIDAE), NO RIO RIBEIRA DE IGUAPE, EM REGISTRO (SP)),
Instituto de Pesca, Santos (Brazil). Secao de Aquicultura.
For primary bibliographic entry see Field 2H.
W88-09774

ECOLOGY OF JACARE PEPIRA RIVER BASIN (47 DEG 55 MIN - 48 DEG 55 MIN W AND 22 DEG 30 MIN - 21 DEG 55 MIN S): PHYSIOGRAPHY (GEOMORPHOLOGY, GEOLOGY, PEDOLOGY AND HYDROGRAPHY) AND SOIL USE (ECOLOGIA DA BACIA DO RIO JACARE PEPIRA (47 DEG 55 MIN - 48 DEG 55 MIN W E 22 DEG 30 MIN - 21 DEG 55 MIN S): FISIOGRAFIA (GEOMORFOLOGIA, GEOLOGIA, PEDOLOGIA E HIDROLOGIA) E USO DO SOLO),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 2H.
W88-09775

ECOLOGY OF JACARE PEPIRA RIVER BASIN: MAJOR IONS (SAO PAULO STATE OF BRAZIL) (ECOLOGIA DA BACIA DO RIO JACARE PEPIRA: IONS DOMINANTES, SAO PAULO, BRASIL),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 2H.
W88-09776

LIMNOLOGICAL AND CLIMATOLOGICAL STUDY OF PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP, WITH THE INTENT TO POPULATE ITS RIVERS WITH THE RAINBOW TROUT, SALMO IRIDEUS GIBBONS (ESTUDO LIMNOLGICO E CLIMATICO DA REGIAO DO PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP, COM VISTAS AO POVOAMENTO COM TRUTA ARCO-IRIS, SALMO IRIDEUS GIBBONS),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 2H.
W88-09779

USE OF MACROBENTHOS AS INDICATORS OF THE WATER QUALITY IN THE RIVERS OF PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP (ORGANISMOS BENTONICOS COMO INDICADORES DA QUALIDADE DA AGUA DE RIOS DO PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 5B.
W88-09780

PHYTOPLANKTON POPULATION DYNAMICS AND CHEMICAL CHARACTERISTICS OF THE SEDIMENTS OF THE SALIHIYAH RIVER, BASRAH, IRAQ,
University Coll., Cardiff (Wales). Dept. of Plant Science.
For primary bibliographic entry see Field 5C.
W88-09806

NATURAL AND COMPULSORY BIOLOGICAL DRIFT IN A SYSTEM OF MOUNTAIN STREAMS UNDER UREA TOP-DRESSING OF THE WATER CATCHMENT AREAS,
Bulgarian Academy of Sciences, Sofia.
For primary bibliographic entry see Field 5C.
W88-09807

COMPARATIVE PRIMARY PRODUCTION IN ONE POND AND RIVER SYSTEM AT BHAGALPUR, INDIA,
Bhagalpur Univ. (India). Post-Graduate Dept. of Botany and Zoology.
For primary bibliographic entry see Field 2H.
W88-09808

TROUT PRODUCTION AND STANDING CROP IN COLORADO'S SMALL STREAMS, AS RELATED TO ENVIRONMENTAL FEATURES,
Colorado Cooperative Fishery Research Unit, Fort Collins.
For primary bibliographic entry see Field 8I.
W88-09817

EFFECTS OF VARIABLE STREAMFLOWS ON GROWTH OF SMALLMOUTH BASS IN THE MAQUOKETA RIVER, IOWA,
Iowa Dept. of Natural Resources, Manchester. Northeast District Headquarters.
For primary bibliographic entry see Field 8I.
W88-09821

USE OF ZOOPLANKTON SIZE TO ASSESS THE COMMUNITY STRUCTURE OF FISH POPULATIONS IN FRESHWATER LAKES,
Cornell Univ., Ithaca, NY. Dept. of Natural Resources.
For primary bibliographic entry see Field 8I.
W88-09822

REDUCTIONS IN ICHTHYOPLANKTON ENTRAINMENT WITH FINE-MESH, WEDGE-WIRE SCREENS,
Versar, Inc., Columbia, MD.
For primary bibliographic entry see Field 8I.
W88-09823

EFFECTS OF VARIATION IN FLOW ON DISTRIBUTION OF NORTHERN SQUAWFISH IN THE COLUMBIA RIVER BELOW MCNARY DAM,
Fish and Wildlife Service, Cook, WA. Willard Field Station.
For primary bibliographic entry see Field 8I.
W88-09830

MACROFAUNA AND ENVIRONMENT OF THE NANPIL-KIEPW RIVER, PONAPE, EASTERN CAROLINE ISLANDS,
Seattle National Fishery Research Center, WA.
For primary bibliographic entry see Field 2H.
W88-09859

HYPHOMYCETES IN THE RIVER KELVIN,
Glasgow Univ. (Scotland). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W88-09861

HYPHOMYCETES IN THE STREAM AT THE ROYAL BOTANIC GARDEN, EDINBURGH AND NOTES ON THEIR DISTRIBUTION IN SCOTLAND,
Royal Botanic Garden, Edinburgh (Scotland).
For primary bibliographic entry see Field 2H.
W88-09862

GENERALIZED ENERGY AND POTENTIAL ENSTROPHY CONSERVING FINITE DIFFERENCE-SCHEMES FOR THE SHALLOW WATER EQUATIONS,
National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies.
For primary bibliographic entry see Field 8B.
W88-09873

TIDAL INFLUENCE ON THE WETLAND COMMUNITY STRUCTURE BEHIND THE DIKE ALONG THE ELBE ESTUARY,
Hamburg Univ. (Germany, F.R.). Inst. fuer Hydrobiologie und Fischereiwissenschaft.
For primary bibliographic entry see Field 2H.
W88-09875

BENTHIC ECOLOGY OF RIVERS IN THE BLUE MOUNTAINS (JAMAICA) PRIOR TO CONSTRUCTION OF A WATER REGULATION SCHEME,
Newcastle upon Tyne Univ. (England). Dept. of Zoology.
For primary bibliographic entry see Field 6G.
W88-09878

INTERSTITIAL FAUNAL COMMUNITIES OF THE HYPORHEIC AND ADJACENT GROUNDWATER BIOTOPES OF A COLORADO MOUNTAIN STREAM,
Colorado Univ. at Boulder.
For primary bibliographic entry see Field 2H.
W88-09879

LEAF LITTER PROCESSING IN COASTAL PLAIN STREAMS AND FLOODPLAINS OF SOUTHEASTERN GEORGIA, U.S.A.,
Georgia Univ., Athens. Dept. of Entomology.
For primary bibliographic entry see Field 2H.
W88-09880

EFFECTS OF SEASONAL AND HYDROLOGICAL INFLUENCES ON THE MACROINVERTEBRATES OF THE RHONE RIVER, FRANCE: II. ECOLOGICAL ASPECTS,
Lyon-1 Univ., Villeurbanne (France). Section of Freshwater Ecology.
For primary bibliographic entry see Field 2H.
W88-09881

MACROZOOBENTHOS OF STRUMA RIVER: AN EXAMPLE OF A RECOVERED COMMUNITY AFTER THE ELIMINATION OF A HEAVY INDUSTRIAL IMPACT WITH SUSPENDED MATERIALS,
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
For primary bibliographic entry see Field 5G.
W88-09886

ALTITUDINAL ZONATION IN A ROCKY MOUNTAIN STREAM,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
For primary bibliographic entry see Field 2H.
W88-09890

PHYTOPLANKTON COMPOSITION AND DYNAMICS IN THE RIVER MEUSE (BELGIUM),
Facultes Universitaires Notre-Dame de la Paix, Namur (Belgium).Dept. of Biology.
For primary bibliographic entry see Field 2H.
W88-09891

PHYTOPLANKTON STUDIES IN THE SZIGETKOZ SECTION OF THE DANUBE DURING 1981-1982,
Magyar Tudomanyos Akademia, Budapest. Station for Danube Research.
For primary bibliographic entry see Field 2H.
W88-09892

ALGAE IN GROUND WATERS BELOW THE ACTIVE STREAM OF A RIVER (BASIN OF THE MORAVA RIVER, CZECHOSLOVAKIA),
Ceskoslovenska Akademie Ved, Trebon. Dept. of Hydrobotany.
For primary bibliographic entry see Field 2H.
W88-09894

EFFECTS OF SHORT-TERM FLOODING ON GROWTH, YIELD, AND MINERAL COMPOSITION OF WHEAT ON SODIC SOIL UNDER FIELD CONDITIONS,
Central Soil Salinity Research Inst., Karnal (India).
For primary bibliographic entry see Field 2I.
W88-09899

SUBSIDENCE IN THE NORTHEASTERN NILE DELTA: RAPID RATES, POSSIBLE CAUSES, AND CONSEQUENCES,
Smithsonian Institution, Washington, DC. Mediterranean Basin Project.
For primary bibliographic entry see Field 2J.
W88-09901

IRON PHOTOREDUCTION AND OXIDATION IN AN ACIDIC MOUNTAIN STREAM,
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-09902

SIMULATION OF RUNOFF AND NITRATE LEACHING FROM AN AGRICULTURAL DISTRICT IN SWEDEN,
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
For primary bibliographic entry see Field 5B.
W88-09913

NONLINEAR, DISCRETE FLOOD EVENT MODELS: I. BAYESIAN ESTIMATION OF PARAMETERS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.

B. C. Bates, and L. R. Townley.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 61-76, May 1988. 5 fig, 2 tab, 29 ref.

Descriptors: *Bayesian method, *Model studies, *Flood forecasting, *Rainfall-runoff relationships, Rainfall, Runoff, Floods, Statistical methods, Prediction, Calibrations, Equations, Catchment areas, Performance evaluation, Storms.

In this paper a Bayesian procedure for parameter estimation is applied to discrete flood event models. The essence of the procedure is the minimization of a sum of squares function for models in which the computed peak discharge is nonlinear in terms of the parameters. This objective function is dependent on the observed and computed peak discharges for several storms on the catchment, information on the structure of observation error, and prior information on parameter values. The posterior covariance matrix gives a measure of the precision of the estimated parameters. The procedure is demonstrated using rainfall and runoff data from seven Australian catchments. It is concluded that the procedure is a powerful alternative to conventional parameter estimation techniques in situations where a number of floods are available for parameter estimation. (See also W88-09916 thru W88-09917) (Author's abstract)
W88-09915

NONLINEAR, DISCRETE FLOOD EVENT MODELS: II. ASSESSMENTS OF STATISTICAL NONLINEARITY,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
B. C. Bates.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 77-89, May 1988. 2 fig, 4 tab, 19 ref.

Descriptors: *Data interpretation, *Floods, *Flood forecasting, *Model studies, *Rainfall-runoff relationships, *Statistical methods, Prediction, Case studies, Performance evaluation, Calibrations, Equations, Storms, Rainfall, Runoff.

The concept of nonlinearity is discussed in relation to flood parameter estimation, its consequences, and the need to assess its extent. Three measures of nonlinearity are considered. They are Beale's measure, a bias calculation, and maximum curvative measures. A case study shows quite clearly that care is required in the application of all three measures to calibrated flood models, and in the interpretation of the measured values. (See also W88-09915 and W88-09917) (Author's abstract)
W88-09916

NONLINEAR, DISCRETE FLOOD EVENT MODELS: III. ANALYSIS OF PREDICTION UNCERTAINTY,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
B. C. Bates, and L. R. Townley.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 91-101, May 1988. 1 fig, 3 tab, 21 ref.

Descriptors: *Data interpretation, *Flood forecasting, *Model studies, *Performance evaluation, *Rainfall-runoff relationships, *Statistical methods, Rainfall, Runoff, Floods, Prediction, Case studies, Calibrations, Equations, Storms, Monte Carlo method.

The precision of flood model predictions was assessed using first-order, second-order and Monte Carlo analyses to evaluate the prediction uncertainty caused by errors in model parameter estimates. A case study is presented to demonstrate the utility of prediction uncertainty analysis. (See also W88-09915 thru W88-09916) (Author's abstract)
W88-09917

TOWARDS A DELIMITATION OF SOUTHWESTERN NIGERIA INTO HYDROLOGICAL REGIONS,
Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Geography.
O. O. Ogunkoya.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 165-177, May 1988. 3 fig, 4 tab, 22 ref.

Descriptors: *Groundwater, *Regional analysis, *Surface-groundwater relations, *Hydrology, *Geohydrology, *Seasonal variation, *Rainfall-runoff relationships, Model studies, Statistical methods, Drainage systems, Water resources development, Nigeria.

Fifteen third-order drainage basins (1:50,000) on the Basement Complex rocks of southwestern Nigeria are classified into hydrological regions using hydrological response parameters of average daily mean specific discharge; daily mean specific discharges equalled or exceeded 90%, 50% and 10% of the study period; variability index of flow; recession constant of flow from peak discharge at the end of the rainy season to minimum discharge in the dry season; total annual runoff; total runoff within the dry season; dry season runoff as a percentage of total annual runoff; runoff coefficient; and, number of days during the study period when there was no flow. An ordination technique and a classification algorithm derived from cluster analysis technique and incorporating analysis of variance tests to determine the level of significance of the homogeneity of derived classes, were used to classify the fifteen basins into five hydrologically homogeneous regions. The constituent basins of each region were observed to share common basin geology. It was observed that those drainage basins having at least 50% of their basin area underlain by quartzitic rocks form two groups and have the most desirable or optimal hydrologic response patterns, desirability or optimality being in terms of ability to potentially meet water resource development requirements (i.e. high perennial discharge, low variability and large groundwater contribution to stream flow). The basins predominantly underlain by granitic gneisses and amphibolitic rocks have much poorer hydrologic response patterns. Hydrological regionalization in southwestern Nigeria appears to be influenced by drainage basin geology while percentage area of the basin underlain by massive quartzites could be used as an index of occurrence of desirable hydrologic response pattern. (Author's abstract)
W88-09922

LEAF DECOMPOSITION IN AN OZARK CAVE AND SPRING,
Arkansas Univ., Fayetteville. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W88-09924

VARIABILITY IN BENTHIC INVERTEBRATE DENSITY ESTIMATES FROM STREAM SAMPLES,
Chadwick and Associates, Littleton, CO.
For primary bibliographic entry see Field 2H.
W88-09927

MUSSEL FAUNA ASSOCIATED WITH WING DAMS IN POOL 7 OF THE MISSISSIPPI RIVER,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 2H.
W88-09928

MORPHOLOGY AND ECOLOGY OF URNATELLA GRACILLS LEIDY, (ENTOPROCTA), A FRESHWATER MACROINVERTEBRATE FROM ARTIFICIAL RIFFLES OF THE TOMBIGBEE RIVER, MISSISSIPPI,
Central Michigan Univ., Mount Pleasant. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W88-09933

NOTE ON THE OCCURRENCE OF UNUSUAL PATCHES OF SENESCENT PERIPHYTON IN AN OKLAHOMA STREAM,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2H.
W88-09936

FACTORS AFFECTING THE DISTRIBUTION OF SPHAERIID BIVALVES IN BRITANNIA BAY OF THE OTTAWA RIVER,
Guelph Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W88-09944

ENVIRONMENT ORIENTED MANAGEMENT SYSTEM OF RIVER BASIN: CASE STUDY IN YAHAGI RIVER BASIN, CENTRAL JAPAN,
Nagoya Univ. (Japan). Dept. of Earth Sciences.
For primary bibliographic entry see Field 6A.
W88-09949

TRANSFER AND OCCURRENCE OF LARGE MERCURY RESISTANCE PLASMIDS IN RIVER EPILITHON,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 2H.
W88-09965

IMPACT OF UREA TOP DRESSING OF FOREST WATER CATCHMENT AREAS ON THE BIOLOGICAL SUFFICIENCY AND WATER QUALITY IN MOUNTAIN STREAMS: III. MACROZOOBENTHIC PRODUCTION,
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
For primary bibliographic entry see Field 5C.
W88-09971

LOG-LOGISTIC FLOOD FREQUENCY ANALYSIS,
Saint Andrews Univ. (Scotland).
M. I. Ahmad, C. D. Sinclair, and A. Werrity.
Journal of Hydrology JHYDA7, Vol. 98, No. 3/4, p 205-224, April 15, 1988. 7 fig, 7 tab, 24 ref.

Descriptors: *Flood frequency, *Statistical methods, *Frequency distribution, *Probabalistic process, Mathematical analysis, Least squares method, Scotland.

The log-logistic (LLG) distribution is evaluated for flood frequency analysis. Some of its properties and methods of parameter estimation are given, including a new method based on generalized least squares (GLS), The performance of the log-logistic distribution is compared with those of the generalized extreme values (GEV), three parameter log-normal (LN3), and three parameter Pearson (P3) distributions. The results are reported in terms of empirical distribution function tests of goodness of fit, on both individual and regional flood series through the application of these distributions to a set of reasonably long annual maximum series for part of Scotland. Some reproductive properties of LLG and GEV are also compared, In terms of four key properties the LLG performs better than the GEV, LN3, and P3 distributions and is thus commended for further analysis. (Author's abstract)
W88-09974

EXPERIMENTAL STUDIES IN STREAM-AQUIFER INTERACTION ALONG THE ARKANSAS RIVER IN CENTRAL KANSAS: FIELD TESTING AND ANALYSIS,
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 4B.
W88-09976

STORAGE-EFFECTIVE DRAINAGE RUNOFF MODEL,
Alberta Dept. of Environment, Edmonton.
For primary bibliographic entry see Field 2A.
W88-09978

DISTRIBUTION OF MACROPHYTES IN RELATION TO ENVIRONMENTAL FACTORS IN THE TER RIVER, NORTHEAST SPAIN,
Barcelona Univ. (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 2H.
W88-09990

FACTORS AFFECTING THE BENTHIC COMMUNITY STRUCTURE OF A DISCONTINUOUS STREAM IN GUADELUPE MOUNTAINS NATIONAL PARK, TEXAS,
Baylor Univ., Waco, TX. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W88-09998

COMPARISON OF INSECT EMERGENCE FROM NATURAL AND ARTIFICIALLY MODIFIED SECTIONS OF A STREAM, THE FUHLENAU, IN SCHLESWIG-HOLSTEIN (VERGLEICHENDE EMERGENZSTUDIEN AN EINEM NATURNAHEN UND EINEM NATURFERNEN ABSCHNITT DES FLIESSGEWASSERSYSTEMS DER FUHLENAU, IN SCHLESWIG-HOLSTEIN),
Kiel Univ. (Germany, F.R.). Zoologisches Inst.und Museum.
For primary bibliographic entry see Field 2H.
W88-09999

INFLUENCE OF SPATIAL VARIABILITY AND SCALE EFFECTS ON THE PARAMETERIZATION OF HYDROLOGIC RESPONSE,
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
E. F. Wood.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-155411/AS. A13 in paper copy, A01 in microfiche. Final Report, Princeton University, Water Resources Program, December 1987. 283 p. Contract No. USGS 14-08-0001-G1138.

Descriptors: *Runoff production, *Rainfall-runoff relationships, *Spatial variability, *Infiltration, *Hydrologic models, Catchment response, Stochastic processes, Model studies, Hydrologic response, Representative elementary areas.

The overall objective of the proposed research was to investigate the effect of spatial variability on the parameterization of hydrologic models for rainfall-runoff transformation over a range of scales. This work was divided into three tasks: (1) Derivation of the statistics of spatially averaged runoff production (infiltration and runoff) under spatially variable soil, topography and rainfall. (2) Development of the concept of a representative elementary area (REA) for spatial averaging of hydrologic processes. (3) Investigation of the transition of hydrologic response as the averaging area passes from smaller to larger scales, and of the relations among parameterization of hydrologic processes at different scales. The following models were developed for runoff production (1) a space-time rainfall generator at the rainband scale and (2) a runoff production model that includes both infiltration excess using soil hydraulic properties and saturation excess using the topographic index of Beven and Kirkby. These models were used to investigate the aforementioned tasks. Results show that the concept of a Representative Elementary Area (REA) exists and is the fundamental spatial building block for catchment modeling. For the investigated topography, the REA was about 1 sq. km. At areas smaller than the REA, the actual pattern of soil and rainfall are REA needed for accurate modeling: for areas larger than the RFA, the derived macro-scale model using the statistics of soil and rainfall patterns gives good results. (USGS)
W88-10024

ECONOMIC AND PREDICTIVE RELIABILITY IMPLICATIONS OF STORMWATER DESIGN METHODOLOGIES,
Florida Univ., Gainesville. Water Resources Research Center.
For primary bibliographic entry see Field 6A.
W88-10030

STUDY OF RUNOFF AND EROSION PROCESSES USING LARGE AND SMALL RAINFALL SIMULATORS,
New Mexico State Univ., Las Cruces. Dept. of Civil Engineering.
T. J. Ward.
New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report 215, November 1986. 71 p, 17 fig, 12 tab, 21 ref. Contract 28-C2-269(USDA). State Project 1423672.

Descriptors: *Computer models, *Data collection, *Hydrologic models, *Hydrologic processes, Infiltration, Parametric hydrology, Runoff plot, Sediment yield, Simulated rainfall, Soil erosion, Watersheds.

Estimation of runoff and sediment yield from small, ungaged watersheds is a difficult hydrologic task. Process oriented mathematical models can be an important part in the solution of this task. Models, however, require some information which is directly related to the hydrologic processes occurring on the watershed. Rainfall simulation is an important experimental technique for gathering such information. Two different simulators were compared on three sites in New Mexico. A small area simulator, 10 sq ft, and a large area simulator, approximately 2000 sq ft, were operated for a total of 60 plot experiments. The large simulator was modified and operated with variable intensity rainfall and with overland flow without rainfall for some of the experiments. Analysis of the data indicates that the simulators provide similar results for hydrologic processes, and that sediment yields averaged about 2.7 times higher for the small simulator. Addition of the variable intensity and overland flow capabilities to the large simulator have provided a means for isolating and studying those two important processes. (Ward-NM St. U.)
W88-10045

RAINFALL-RUNOFF DATA FOR SOMERSET COUNTY, NEW JERSEY,
Geological Survey, Trenton, NJ. Water Resources Div.
J. B. Campbell.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Open-File Report 87-384, 1987. 161 p, 11 fig, 1 tab, 12 ref.

Descriptors: *Rainfall, *Stream discharge, *Urban runoff, *Storm runoff, *Rainfall-runoff relationships, *New Jersey, Urbanization, Rainfall rate, Flood peak, Somerset County.

Rainfall-runoff data are presented for eight urbanizing drainage basins in Somerset County, New Jersey, for the 1980 through 1984 water years. In order to improve the existing methods for estimating flood frequency and magnitude throughout the county, and to assist the county in its flood-monitoring efforts by providing real-time data, rainfall-runoff data were collected and a data base was created. The rainfall-runoff data were recorded at 5-minute intervals and were stored in the U.S. Geological Survey, New Jersey District computer. Rainfall data were collected at two sites within each drainage basin in order to improve areal coverage and data continuity. Data from eight rainfall-runoff gaging stations and eight auxiliary rainfall gages are summarized. Rainfall and runoff data for selected storms also are summarized. (USGS)
W88-10049

HYDROLOGY OF AREA 53, NORTHERN GREAT PLAINS AND ROCKY MOUNTAINS COAL PROVINCES, COLORADO, WYOMING, AND UTAH,
Geological Survey, Lakewood, CO. Water Resources Div.
N. E. Driver, J. M. Norris, and G. Kuhn.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources Investigations Report 83-765, 1984. 93 p, 70 fig, 8 tab, 181 ref.

Descriptors: *Geohydrology, *Coal, *Hydrology, *Surface-water quality, *Groundwater quality, *Yampa River, *White River, *Colorado, Surface water, Groundwater, Wyoming, Utah.

The hydrology of Area 53 in northwestern Colorado, south-central Wyoming, and northeastern Utah was characterized. The two major rivers, the Yampa and the White Rivers, originate in humid granitic and basaltic mountains, then flow over sedimentary rocks underlying semiarid basins to their respective confluences with the Green River. Annual precipitation in the mountains, as much as 60 inches, is generally in the form of snow. Snowmelt produces most streamflow. Precipitation in the lower altitude sedimentary basins, ranging from 8 to 16 inches, is generally insufficient to sustain streamflow; therefore, most streams originating in the basins (where most of the steams in coal-mining areas originate) are ephemeral. Streamflow quality is best in the mountains where dissolved-solids concentrations generally are small. As streams flow across the sedimentary basins mineral dissolution from the sedimentary rocks and irrigation water with high mineral content increase the dissolved-solids concentrations in a downstream direction. Groundwater supplies are restricted by the low yields of wells due to small permeability. Most groundwater use is for domestic and stock-watering purposes. Dissolved-solids concentrations for aquifers sampled in Area 53 range from a minimum of 46 milligrams per liter to a maximum of 109,000 milligrams per liter. (USGS)
W88-10055

GEOHYDROLOGIC AND SURFACE-WATER DATA FOR THE SACO RIVER VALLEY GLACIAL AQUIFER FROM BARTLETT, NEW HAMPSHIRE TO FRYEBURG, MAINE: OCTOBER 1983 THROUGH JANUARY 1986,
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 2F.
W88-10056

INVESTIGATION OF TECHNIQUES TO ESTIMATE RAINFALL-LOSS PARAMETERS FOR ILLINOIS,
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 2A.
W88-10064

HYDRAULICS AND BED MATERIAL TRANSPORT AT HIGH FINE SUSPENDED SEDIMENT CONCENTRATIONS,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W88-10085

2F. Groundwater

MANUAL OF GROUND-WATER QUALITY SAMPLING PROCEDURES,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 7B.
W88-08970

GROUND-WATER TRACERS,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
S. N. Davis, D. J. Campbell, H. W. Bentley, and T. J. Flynn.
National Water Well Association, Worthington, Ohio. 1985. 200 p, 36 fig, 13 tab, 168 ref, 5 append. EPA Contract CR-810036.

Descriptors: *Path of pollutants, *Groundwater movement, Groundwater pollution, *Tracers, *Groundwater, Geohydrology, Permeability coefficient, Porosity, Dyes, Viruses, Gases, Bacteria, Yeast, Radionuclides, Temperature.

As used in geohydrology, a tracer is matter or energy carried by groundwater which will give information concerning the direction of movement and/or velocity of the water and potential contaminants which might be transported by the water. If enough information is collected, the study of tracers can also help with the determination of

hydraulic conductivity, porosity, dispersivity, chemical distribution coefficients, and other geohydrologic parameters. A tracer can be entirely natural, such as fuel oil from a ruptured storage tank; or it can be introduced intentionally, such as dyes placed in water flowing within limestone caverns. The purpose of this manual is to provide a guide to the use of groundwater tracers for practicing engineers, hydrologists, and groundwater geologists. Specifically, the manual is concerned with the selection of tracers, their field application, collection of samples containing tracers, sample analysis, and interpretation of the results. Types of tracers presented are: temperature, solid particles, yeast, bacteria, viruses, spores, ions, dyes, gases, stable isotopes, and radionuclides. (Lantz-PTT)
W88-08971

GROUND-WATER MODELING,
GeoTrans, Inc., Reston, VA.
J. W. Mercer, and C. R. Faust.
National Water Well Association, Worthington, Ohio. 1981. 60 p, 40 fig, 2 tab, 8 ref.

Descriptors: *Groundwater movement, *Model studies, Hydrologic models, Mathematical models, Numerical analysis.

This book explains basic concepts in mathematical and numerical methods for groundwater modeling, and also presents the limitations and uses of groundwater models as they are applied to help solve the complicated groundwater problems of today. The articles represent chapters and are organized as follows: (1) overview; (2) mathematical models; (3) numerical models; (4) applications; and (5) recent developments. This book, by itself, is not sufficient to perform a modeling study; it is designed to be used with other, more detailed references. The goal is to fill the gap between those who develop models, and hydrologists and managers who apply models and make use of modeling results. (Lantz-PTT)
W88-08975

GROUND WATER HYDROLOGY FOR WATER WELL CONTRACTORS.
National Water Well Association, Worthington, OH.
National Water Well Association, Worthington, Ohio. 1982. 288 p. Edited by Stuart Smith, John Poehlman, Dana Armitage, David Nielsen, Joseph Ritchie, and Harold Heiss.

Descriptors: *Groundwater, *Geohydrology, *Hydrologic studies, *Wells, Drilling, Groundwater protection, Filtration, Aquifers.

This manual, based on a 1969 edition, is an introduction to groundwater, geology and tools for finding and quantifying groundwater supplies. As groundwater is so closely involved with its geologic surroundings, more information is devoted to geologic topics than is usual in hydrology texts. Sectional divisions address the following topics: (1) Geology (includes some principles of geology, structures and landscapes, and faults); (2) Hydrology (includes the hydrologic cycle, unconfined or water table aquifers, confined or artesian groundwater, and springs); (3) Tools for studying groundwater systems; (4) The resource and its protection; and (5) Groundwater resources and drilling in the United States and Caribbean Islands. (Lantz-PTT)
W88-08977

INTRODUCTION TO ARTIFICIAL GROUNDWATER RECHARGE,
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
For primary bibliographic entry see Field 4B.
W88-08980

METHODS FOR DETERMINING THE LOCATION OF ABANDONED WELLS,
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 7B.
W88-08982

AQUIFER ANALYSIS: A COMPREHENSIVE COLLECTION OF THE MOST IMPORTANT LITERATURE RELATING TO AQUIFER ANALYSIS.
Association of Ground Water Scientists and Engineers, Dublin, Ohio. 635 p. Selected by Dr. Yilder Senay.

Descriptors: *Groundwater, *Aquifers, *Water analysis, *Literature review, Information exchange, Confined aquifers, Anisotropy, Drawdown, Flowing wells, Fracture permeability, Groundwater barriers.

This volume contains a comprehensive collection of papers prepared for an intensive 5-day course of study. They provide a retrospective review of literature pertaining to aquifer analysis. Sections present material on: (1) confined aquifers; (2) semiconfined aquifers; (3) water table aquifers; (4) karstified aquifers; (5) anisotropic aquifers; (6) constant head tests; (7) step-drawdown tests; (8) slug test analysis; (9) analysis of low-permeability formations; and (10) fractured bedrock aquifers. (Lantz-PTT)
W88-08985

CONSTRUCTION DEWATERING: A GUIDE TO THEORY AND PRACTICE,
Moretrench American Corp., Rockaway, NJ.
For primary bibliographic entry see Field 8B.
W88-08989

PROCEEDINGS OF THE FIRST NATIONAL OUTDOOR ACTION CONFERENCE ON AQUIFER RESTORATION, GROUND WATER MONITORING AND GEOPHYSICAL METHODS.
For primary bibliographic entry see Field 5G.
W88-08991

INNOVATIVE BIOLOGICAL TREATMENT OF CONTAMINATED GROUNDWATER,
DETOX, Inc., Dayton, OH.
For primary bibliographic entry see Field 5G.
W88-08992

SMALL SCALE WATER TREATMENT SYSTEMS FOR REMEDIATING CONTAMINATED GROUND WATER,
Geraghty and Miller, Inc., Oak Ridge, TN.
For primary bibliographic entry see Field 5G.
W88-08993

DRAWDOWN IMPACTS IN DENSE NON-AQUEOUS PHASE LIQUIDS,
Conestoga-Rovers and Associates, Waterloo (Ontario).
For primary bibliographic entry see Field 5G.
W88-08994

HYDROCARBON RECOVERY PUMP FOR LOW TRANSMISSIVITY AQUIFERS,
Geoscience Consultants Ltd., Albuquerque, NM.
For primary bibliographic entry see Field 5G.
W88-08995

GROUND WATER MONITORING AND MITIGATION EFFORTS AT AN INACTIVE TAILINGS POND IN NORTHWEST MONTANA,
For primary bibliographic entry see Field 5B.
W88-08996

AMMONIA AND NITRATE MIGRATION FROM THE VADOSE ZONE TO THE GROUND WATER SYSTEM: CONTAINMENT, RECOVERY, AND NATURAL RESTORATION,
In-Situ, Inc., Laramie, WY.
For primary bibliographic entry see Field 5G.
W88-08997

CONTROL OF GROUND WATER CONTAMINATION IN AN ALLUVIAL FAN AQUIFER BY A DUAL HYDRAULIC BARRIER,
Stauffer Chemical Co., Richmond, CA.
For primary bibliographic entry see Field 5G.
W88-08998

REMEDIATION OF HYDROCARBON CONTAMINATION WITHIN TRENCH-FILL MATERIALS ASSOCIATED WITH A 48-INCH WATER MAIN,
WESTEC Services, Inc., San Diego, CA.
For primary bibliographic entry see Field 5G.
W88-08999

DECONTAMINATION OF RUBBER HOSE AND 'TEFLON' TUBING FOR GROUND WATER SAMPLING,
California Regional Water Quality Control Board, Sacramento. Central Valley Region.
For primary bibliographic entry see Field 5A.
W88-09000

RESOLUTION PROBLEMS WITH OBTAINING ACCURATE GROUND WATER ELEVATION MEASUREMENTS IN A HYDROGEOLOGIC SITE INVESTIGATION,
EMCON Associates, San Jose, CA.
For primary bibliographic entry see Field 7B.
W88-09001

VALUE OF ON-SITE MEASUREMENTS IN MAXIMIZING GROUND WATER SAMPLING RELIABILITY,
Hydrolab Corp., Austin, TX.
For primary bibliographic entry see Field 7B.
W88-09002

FALSE WHAT: FALSE POSITIVE RATES IN GROUNDWATER MONITORING,
For primary bibliographic entry see Field 7B.
W88-09003

GROUND WATER SAMPLING: ADDRESSING THE TURBULENT INCONSISTENCIES,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Solid Waste Management.
For primary bibliographic entry see Field 7A.
W88-09004

NUMERICAL EVALUATION OF MONITORING WELL DESIGN,
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 7A.
W88-09006

USE OF GROUND WATER TRACER DURING WELL INSTALLATION,
Woodward-Clyde Consultants, Chicago, IL.
For primary bibliographic entry see Field 7B.
W88-09007

MONITOR WELLS FOR DEPTH-DISCRETE SAMPLING: A COST-EFFECTIVE ALTERNATIVE DESIGN,
Geoscience Consultants Ltd., Albuquerque, NM.
For primary bibliographic entry see Field 7A.
W88-09008

INSTALLATION OF A SEDIMENT-FREE MONITORING WELL IN FINE-GRAINED SEDIMENT,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
For primary bibliographic entry see Field 7B.
W88-09009

USE OF ODEX DRILLING SYSTEM FOR MONITORING WELL INSTALLATION IN AQUIFER CONTAINING GLACIAL BOULDERS,
For primary bibliographic entry see Field 7A.
W88-09012

USING THE DRILL THROUGH CASING HAMMER METHOD FOR MONITORING WELL CONSTRUCTION AND WATER QUALITY CHARACTERIZATION IN A METAL CONTAMINATED GRAVEL, COBBLE AND BOULDER AQUIFER,
Montana Univ., Missoula. Dept. of Geology.
For primary bibliographic entry see Field 7B.
W88-09013

USE OF A MATHEMATICAL MODEL TO DESIGN LYSIMETER NETWORKS FOR SURFACE IMPOUNDMENTS AND LANDFILLS,
In-Situ, Inc., Laramie, WY.
For primary bibliographic entry see Field 7A.
W88-09014

FACTORS AFFECTING THE UTILITY OF SOIL VAPOR ASSESSMENT DATA,
EA Engineering, Science, and Technology, Inc., Sparks, MD.
For primary bibliographic entry see Field 7A.
W88-09015

SOIL GAS SAMPLING STRATEGIES: DEEP VS. SHALLOW AQUIFERS,
For primary bibliographic entry see Field 7A.
W88-09016

NEUTRON MONITORING IN THE UNSATURATED ZONE,
LeRoy Crandall and Associates, Glendale, CA.
For primary bibliographic entry see Field 7A.
W88-09017

IN-SITU HYDRAULIC CONDUCTIVITY MEASUREMENTS OF SLOWLY PERMEABLE MATERIALS USING A MODIFIED GUELPH PERMEAMETER AND THEGUELPH INFILTRAMETER,
Guelph Univ. (Ontario). Dept. of Land Resource Science.
For primary bibliographic entry see Field 7A.
W88-09018

APPLICATION OF GRAVITY AND SEISMIC METHODS IN HYDROGEOLOGICAL MAPPING AT A LANDFILL SITE IN ONTARIO,
Ontario Ministry of the Environment, Toronto.
For primary bibliographic entry see Field 7A.
W88-09019

APPLICATION OF SEISMIC REFRACTION AND TERRAIN CONDUCTIVITY METHODS AT A GROUND WATER POLLUTION SITE IN NORTH-CENTRAL NEW JERSEY,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 7A.
W88-09020

OFF-END SURFACE SEISMIC REFLECTION SOUNDING WITH VERTICAL SEISMIC PROFILING IN GLACIAL TERRAIN,
Minnesota Dept. of Natural Resources, St. Paul. Div. of Waters.
For primary bibliographic entry see Field 7A.
W88-09021

USE OF GROUND-PENETRATING RADAR FOR DETERMINING DEPTH TO THE WATER TABLE ON CAPE COD, MASSACHUSETTS,
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7B.
W88-09022

SHALLOW STRATIGRAPHIC REFLECTIONS FROM GROUND PENETRATING RADAR,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 7B.
W88-09023

CHARACTERIZATION OF AN ABANDONED WASTE SITE USING PROTON MAGNETOMETRY AND COMPUTER GRAPHICS,
For primary bibliographic entry see Field 5A.
W88-09024

USE OF AN ELECTROMAGNETIC INDUCTION TECHNIQUE IN SUBSURFACE HYDROCARBON INVESTIGATIONS,
For primary bibliographic entry see Field 5A.
W88-09025

USE OF TIME DOMAIN ELECTROMAGNETIC SOUNDINGS FOR MAPPING SEA WATER INTRUSION IN MONTEREY CO., CA.: A CASE HISTORY,
Monterey County Food Control and Water Conservation District, Salinas, CA.
For primary bibliographic entry see Field 5A.
W88-09026

GEOPHYSICAL GROUND WATER MONITORING PROGRAM FOR A SANITARY LANDFILL: IMPLEMENTATION AND PRELIMINARY ANALYSIS,
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 5A.
W88-09027

DETAILED SUBSURFACE MAPPING OF FRACTURE CLOSURE IN A CRYSTALLINE BEDROCK FORMATION,
Buchart-Horn, Inc., York, PA.
G. A. Johnson, and T. E. Saylor.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 643-657. 4 fig, 11 ref.

Descriptors: *Water table, *Vertical electrical sounding, *Water-bearing formations, *Aquifer characteristics, *Resistivity, *Mapping, *Fractures, *Analytical methods, *Measuring instruments, *Model studies, *Data interpretation, *Groundwater monitoring, *Groundwater management, *Hydraulic conductivity, *Permeability coefficient, *Groundwater movement, *Sampling devices, *Remote sensing, *Geophysics, Computers, Mathematical studies, Aquifers, Monitoring wells, Solute transport, Groundwater, Pennsylvania, Aquitards.

Using a commercially available automated electrical resistivity investigation device, 59 vertical electrical soundings (VES) were conducted in a closely-spaced exploratory grid. Reducing the large volume of field data with mainframe computer processing, the data was converted to Wenner apparent resistivity values. Microcomputers were then used to model the Wenner values to define the subsurface electrical resistivity units, including the thickness and true resistivity of the subsurface layers. The modeling results were interpreted based on geologic and hydrogeologic concepts. Conventional engineering/geologic methods were used to confirm the presence and location of the aquifer, aquitard, and the unique interface existing between these two hydrogeologic units. During construction of exploratory wells by air rotary methods, a definite lithological interface was encountered at the proposed aquifer-aquitard interface. Piezometric nests, down-hole geophysics, pump tests, and NX core borings were used to confirm and better define the geologic and hydrogeologic characteristics of the Marburg Schist (unit of the Wissahickon Formation Pennsylvania). The electrical resistivity investigation, in combination with sound geologic and hydrogeologic concepts provided for the: (1) identification of different lithological and hydrogeologic units not previously defined; (2) establishment of a relationship between electrical resistivity and hydraulic conductivity; (3) detailed mapping of the groundwater system, including flow directions, boundaries, and aquifer isopachs; and (4) delineation of opened or closed fractures within a crystalline bedrock environment. (See also W88-08991) (Author's abstract)
W88-09028

RESOURCE DOCUMENT FOR CONSIDERATION OF THE NEWBERG AREA AQUIFER AS A SOLE SOURCE AQUIFER.
Environmental Protection Agency, Seattle, WA. Office of Ground Water.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-224671. Price codes: A02 in paper copy, A01 in microfiche. July 1987. 12 p, 1 tab, 7 ref, 1 map.

Descriptors: *Newberg aquifer, *Drinking water, *Water supply development, *Aquifer management, *Aquifer characteristics, Aquifers, Groundwater management, Environmental impact statement, Water supply, Public health, Washington, Safe Drinking Water Act, Water demand, Groundwater recharge, Groundwater pollution.

On January 16, 1984, the Region 10 Office of the Environmental Protection Agency (EPA) received a petition from the Newberg Organization, Inc. to designate the Newberg Aquifer in the state of Washington as a sole source of drinking water for that area. This document summarizes available information on the petitioned area and its groundwater resources to provide a basis for EPA action regarding sole source aquifer designation under the Safe Drinking Water Act. The geography, climate, population, geology, and occurrence of groundwater for the Newberg Aquifer area are described. Aquifer and recharge area boundaries are discussed along with surface water, water supply, groundwater quality, potential for contamination, and alternative water sources for the sole source petition area. (Geiger-PTT)
W88-09033

ORGANIC COMPOUNDS AT THE SRP OLD BURIAL GROUND FOR LOW-LEVEL RADIOACTIVE WASTE,
Savannah River Lab., Aiken, SC.
For primary bibliographic entry see Field 5B.
W88-09035

MONITOR WELL INSTALLATION AT K-1407-B AND K-1407-C SURFACE IMPOUNDMENTS AT THE OAK RIDGE GASEOUS DIFFUSION PLANT,
Geraghty and Miller, Inc., Oak Ridge, TN.
For primary bibliographic entry see Field 7A.
W88-09086

BASIC DATA REPORT, DRILLING AND WELL INSTALLATION AT TEST SITES MSB-12 AND MSB-34.
Geraghty and Miller, Inc., Tampa, FL.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-010161. Price codes: A04 in paper copy, A01 in microfiche. January 1984. 8 p, 1 fig, 1 tab, 4 append. Report No. DOE/SR/00001-T123.

Descriptors: *Aquifer characteristics, *Test wells, *Network design, *Drilling, *Core logging, *Monitoring, Deep wells, Boreholes, Aquifer testing, Geology, Savannah River Plant, South Carolina, Remote sensing, Geologic formations, Aquifers, Groundwater management, Geohydrology.

The work performed by Geraghty and Miller, Inc. at test sites MSB-12 and MSB-34 in the A-M Area of the Savannah River Plant is documented. At site MSB-12, two monitoring wells were drilled and completed in the upper part of the Middendorf (Tuscaloosa) Formation. The subsurface geology at site MSB-34 was explored by a test hole drilled in two stages to a total depth of 660 ft (MSB-34 TA). Information obtained from lithologic and electric logging was used in the design of a cluster of five monitoring wells installed at the site. The deepest wells of these five were the MSB-34 TA and MSB-34 TB, installed in the upper part of the Middendorf (Tuscaloosa) Formation. In addition, the well cluster comprises three shallower monitoring wells, tapping strata of Tertiary age at depths of 268.5, 200 ft, and 161 ft. Data obtained from the wells indicates the absence of major clay zones within the deposits of Tertiary age at sites MSB-34 and MSB-12. At site MSB-34, clayey

sands and gravels below 265 ft are arkosic and presumably are part of the Middendorf (Tuscaloosa) Formation. Predominantly clayey strata have been logged from 277 to 303 ft. At site MSB-12, the strata between 236 and 273 are silty and sandy clays, with clayey sands, that may be part of the Ellenton Formation. The underlying strata, to depths of 316 ft, are largely clays, with small amounts or lenses of silt and sand. Clay zones within the aquifer are generally thin and lenticular, consisting of silty and sandy clay. An exception are the clays separating the upper from the lower aquifer unit in the Middendorf (Tuscaloosa) Formation, which are present at both sites. The continuity of clay strata, especially those comprising the Ellenton Formation, and their respective vertical permeabilities are of primary concern in the present aquifer-contamination study. A gamma-ray log evaluation of the wells penetrating the upper Middendorf would provide a much needed expanded hydrogeological data base for the entire M Area. (Geiger-PTT)
W88-09088

EVALUATION OF PESTICIDES IN GROUND WATER.
For primary bibliographic entry see Field 5B.
W88-09089

PROCESSES AND FACTORS AFFECTING TRANSPORT OF PESTICIDES TO GROUND WATER,
Washington State Univ., Pullman. Dept. of Agronomy and Soils.
For primary bibliographic entry see Field 5B.
W88-09090

SOIL CHARACTERISTICS AFFECTING PESTICIDE MOVEMENT INTO GROUND WATER,
Agricultural Research Service, Beltsville, MD.
For primary bibliographic entry see Field 5B.
W88-09091

GEOHYDROLOGY OF A FIELD SITE: STUDY OF PESTICIDE MIGRATION IN THE UNSATURATED AND SATURATED ZONES OF DOUGHERTY PLAIN, SOUTHWEST GEORGIA,
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-09094

APPLICATIONS OF SURFACE GEOPHYSICAL METHODS TO GROUND WATER POLLUTION INVESTIGATIONS,
Weston (Roy F.), Inc., Edison, NJ. Raritan Center.
For primary bibliographic entry see Field 7B.
W88-09096

FATE OF ALDICARB IN WISCONSIN GROUND WATER,
Wisconsin Univ.-Madison. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W88-09101

COMPLEXITY OF CONTAMINANT DISPERSAL IN A KARST GEOLOGICAL SYSTEM,
Pennsylvania State Univ., University Park. Dept. of Entomology.
For primary bibliographic entry see Field 5B.
W88-09102

METHOD FOR THE ASSESSMENT OF GROUND WATER CONTAMINATION POTENTIAL: USING A PESTICIDE ROOT ZONE MODEL (PRZM) FOR THE UNSATURATED ZONE,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W88-09107

FIELD VALIDATION OF GROUND WATER MODELS,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 5B.
W88-09110

TOXICOLOGICAL AND EPIDEMIOLOGICAL EFFECTS OF PESTICIDE CONTAMINATION IN CALIFORNIA GROUND WATER.
California Dept. of Health Services, Berkeley.
For primary bibliographic entry see Field 5C.
W88-09111

RISK ASSESSMENT APPROACHES FOR GROUND WATER CONTAMINATION BY PESTICIDES AND OTHER ORGANIC SUBSTANCES,
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
For primary bibliographic entry see Field 5G.
W88-09113

INDUSTRY PERSPECTIVE ON PESTICIDE AND GROUND WATER LEGISLATION,
CIBA-GEIGY Corp., Greensboro, NC. Agricultural Div.
For primary bibliographic entry see Field 6E.
W88-09114

GROUND WATER REGULATIONS: IMPACT, PUBLIC ACCEPTANCE, AND ENFORCEMENT,
Wisconsin Dept. of Agriculture, Madison. Trade and Consumer Protection.
For primary bibliographic entry see Field 6E.
W88-09115

TWO GROUND WATER CONTAMINATION PROBLEMS: CASE STUDIES,
New York State Dept. of Health, Albany. Bureau of Toxic Substance Assessment.
For primary bibliographic entry see Field 5B.
W88-09117

EMERGING ROLE OF PESTICIDE REGULATION IN FLORIDA DUE TO GROUND WATER CONTAMINATION,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 6E.
W88-09118

REMEDIAL PROGRAMS FOR GROUNDWATER SUPPLIES CONTAMINATED BY GASOLINE,
For primary bibliographic entry see Field 5G.
W88-09134

SUBSURFACE HYDROCARBON SPILL, IDENTIFICATION AND RECOVERY,
For primary bibliographic entry see Field 5A.
W88-09135

TRICHLOROETHYLENE OCCURRENCE AND GROUND-WATER RESTORATION IN HIGHLY ANISOTROPIC BEDROCK: A CASE STUDY,
SMC Martin, Inc., Valley Forge, PA.
For primary bibliographic entry see Field 5B.
W88-09139

TREATMENT ALTERNATIVES EVALUATION FOR AQUIFER RESTORATION,
For primary bibliographic entry see Field 5G.
W88-09141

LIMITATIONS IN IMPLEMENTING AQUIFER RECLAMATION SCHEMES,
Schmidt (Kenneth D.), Fresno, CA.
For primary bibliographic entry see Field 5G.
W88-09142

DESIGN, OPERATION AND RESULTS OF A PILOT PLANT FOR REMOVAL OF CONTAMINANTS FROM GROUND WATER,
Weston (Roy. F.) Inc., Concord, NH.
For primary bibliographic entry see Field 5G.
W88-09143

GROUND-WATER DECONTAMINATION AT THE ROCKY MOUNTAIN ARSENAL,
Rubel and Hager, Inc., Tucson, AZ.
For primary bibliographic entry see Field 5G.
W88-09144

ASSESSMENT OF GROUND-WATER CONTAMINATION AND REMEDIAL ACTION FOR A HAZARDOUS WASTE FACILITY IN THE GULF COAST,
Ecology and Environment, Inc., Kansas City, KS.
For primary bibliographic entry see Field 5G.
W88-09145

CONTAMINATED GROUND-WATER RECOVERY SYSTEM ANALYSIS, DESIGN AND CONSTRUCTION AT A WASTE MANAGEMENT FACILITY LOCATED IN A GULF COASTAL PLAIN,
For primary bibliographic entry see Field 5G.
W88-09146

DETECTION, CORRECTION AND RESTORATION OF MINING SOLUTIONS IN A CONFINED AQUIFER AT AN IN SITU URANIUM MINE,
For primary bibliographic entry see Field 5G.
W88-09147

LABORATORY STUDIES ON NATURAL RESTORATION OF GROUND WATER AFTER IN SITU LEACH URANIUM MINING,
For primary bibliographic entry see Field 5G.
W88-09148

MASSACHUSETTS WATER-SUPPLY CONTAMINATION CORRECTION PROGRAM,
For primary bibliographic entry see Field 6E.
W88-09149

COMPREHENSIVE AQUIFER EVALUATION AND LAND-USE PLANNING FOR AQUIFER RESTORATION AND PROTECTION IN ACTON, MASSACHUSETTS,
For primary bibliographic entry see Field 6B.
W88-09150

RATIONAL APPROACH TO THE DESIGN OF GROUND-WATER MONITORING SYSTEMS, USING BAYESIAN DECISION THEORY,
Holzmacher, McLendon and Murrell, Melville, NY.
For primary bibliographic entry see Field 7A.
W88-09153

COST-EFFECTIVE TECHNIQUE FOR RECONNAISSANCE EVALUATION OF AQUIFERS,
For primary bibliographic entry see Field 7B.
W88-09154

WILL MY MONITORING WELLS SURVIVE DOWN THERE: DESIGN AND INSTALLATION TECHNIQUES FOR HAZARDOUS WASTE STUDIES,
Western Water Consultants, Inc., Sheridan, WY.
For primary bibliographic entry see Field 7B.
W88-09155

ALTERNATIVE WELL SEAL IN HIGHLY MINERALIZED GROUND WATER,
For primary bibliographic entry see Field 7B.
W88-09156

BACKGROUND GROUND-WATER QUALITY MONITORING: WELL INSTALLATION TRAUMA,
Jordan Gorrill Associates, Portland, ME.
For primary bibliographic entry see Field 7B.
W88-09157

TECHNIQUE FOR RENOVATING CLOGGED MONITOR WELLS,
For primary bibliographic entry see Field 7B.
W88-09158

BORE-VOLUME PURGING TO IMPROVE MONITORING WELL PERFORMANCE: AN OFTEN-MANDATED MYTH,
For primary bibliographic entry see Field 7B.
W88-09159

LABORATORY INVESTIGATION OF THE PURGING BEHAVIOR OF SMALL-DIAMETER MONITORING WELLS,
For primary bibliographic entry see Field 7B.
W88-09160

CHEMICAL PROBLEMS IN GROUND-WATER MONITORING PROGRAMS,
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
For primary bibliographic entry see Field 7A.
W88-09161

USE OF GEOPHYSICAL TECHNIQUES TO DELINEATE GROUND-WATER CONTAMINATION,
For primary bibliographic entry see Field 7A.
W88-09164

REFINEMENT OF THE SHALLOW SEISMIC REFLECTION TECHNIQUE IN DETERMINING SUBSURFACE ALLUVIAL STRATIGRAPHY,
Ecology and Environment, Inc., Kansas City, KS.
For primary bibliographic entry see Field 7B.
W88-09165

APPROACH TO DRILLING AND INSTALLATION OF GROUND-WATER MONITORING WELLS ON HAZARDOUS WASTE SITES,
For primary bibliographic entry see Field 7A.
W88-09167

GROUND-WATER MONITORING IN CLAY-RICH STRATA - TECHNIQUES, DIFFICULTIES AND POTENTIAL SOLUTIONS,
Becon Construction Co., Houston TX. Mining Services Group.
For primary bibliographic entry see Field 7A.
W88-09170

MONITORING AND MATHEMATICAL MODELING OF CONTAMINATED GROUND-WATER PLUMES IN PALEOFLUVIAL ENVIRONMENTS FOR REGULATORY PURPOSES,
For primary bibliographic entry see Field 7A.
W88-09171

PRACTICAL GEOHYDROLOGICAL ASPECTS OF GROUND-WATER CONTAMINATION,
For primary bibliographic entry see Field 5B.
W88-09172

FIELD APPLICATIONS OF CHEMICAL TIME-SERIES SAMPLING,
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
For primary bibliographic entry see Field 7B.
W88-09173

VELOCITY PLOTS AND CAPTURE ZONES OF PUMPING CENTERS FOR GROUND-WATER INVESTIGATIONS,
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
For primary bibliographic entry see Field 7B.
W88-09174

DIRECT MEASUREMENT OF GASOLINE FLOW,
K-V Associates, Inc., Falmouth, MA.
For primary bibliographic entry see Field 7B.
W88-09175

BIODEGRADATION POTENTIAL OF GROUND-WATER BACTERIA,
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
R. J. Larson, and R. M. Ventullo.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 402-409, 2 fig, 3 tab, 30 ref.

Descriptors: *Fate of pollutants, *Groundwater pollution, *Biodegradation, *Heterotrophic bacteria, *Bacteria, Bacterial analysis, Microbial degradation, Substrates, Oligotrophy, Bacterial physiology, Clays, Metabolism, Carbon sources, Nutrients.

This paper discusses techniques for measuring the number, activity and biodegradation potential of heterotrophic bacteria in groundwater. Data describing the application of these techniques to suspended bacteria in a clay-based groundwater system are also presented. Results of applications of the techniques to a clay-based groundwater system showed that bacteria were present at significant levels in the groundwater samples tested and were the predominant microbial species. However, only 1 to 10 percent of the total bacteria present appeared to be metabolically active and capable of growth on dilute complex nutrient media. The activity of groundwater bacteria, based on turnover time and specific activity indices for several natural substrates, approximated that typical of microorganisms in oligotrophic surface waters. The biodegradation potential of groundwater bacteria on natural and xenobiotic substrates was variable and related to suitability of the substrate as a carbon and energy source. For degradable substrates, rates of biodegradation were fairly rapid, even in the oligotrophic ground water tested. (See also W88-09129) (Friedmann-PTT)
W88-09176

CORRELATION OF GEOPHYSICAL AND ORGANIC VAPOR ANALYZER DATA OVER A CONDUCTIVE PLUME CONTAINING VOLATILE ORGANICS,
Technos, Inc., Miami, FL.
For primary bibliographic entry see Field 7A.
W88-09178

TWO CASE HISTORIES ON THE DESIGN AND PUMP TESTING OF INDIVIDUAL AQUIFERS WITH DUAL COMPLETED WELLS,
Blatchley Associates, Inc., Denver, CO.
For primary bibliographic entry see Field 7A.
W88-09179

STUDY OF CONTAMINANT PLUME CONTROL IN FRACTURED-POROUS MEDIA,
For primary bibliographic entry see Field 5G.
W88-09181

CONTAMINATED GROUND-WATER CONTAINMENT/TREATMENT SYSTEM AT THE NORTHWEST BOUNDARY, ROCKY MOUNTAIN ARSENAL, COLORADO.
Corps of Engineers, Omaha, NE.
For primary bibliographic entry see Field 5G.
W88-09182

GROUNDWATER TREATMENT TECHNOLOGY,
DETOX, Inc., Dayton, OH.
For primary bibliographic entry see Field 5G.
W88-09238

PROCEEDINGS OF NWWA WESTERN REGIONAL CONFERENCE ON GROUND WATER MANAGEMENT.
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 4B.
W88-09240

CONJUNCTIVE USE--FIRST BY ACCIDENT, NOW BY MANAGEMENT,
Nebraska Dept. of Water Resources, Omaha.
For primary bibliographic entry see Field 4B.
W88-09241

CONJUNCTIVE USE AND GROUND WATER MANAGEMENT IN ORANGE COUNTY, CALIFORNIA,
For primary bibliographic entry see Field 4B.
W88-09242

CONJUNCTIVE USE OF GROUND WATER AND SURFACE WATER IN THE SOUTH PLATTE RIVER BASIN--A CASE STUDY OF THE CENTRAL COLORADO WATER CONSERVANCY DISTRICT,
Central Colorado Water Conservancy District, Greeley.
For primary bibliographic entry see Field 4B.
W88-09243

CONJUNCTIVE USE OF BRACKISH COASTAL GROUND WATER BASINS IN SAN DIEGO COUNTY, CALIFORNIA,
San Diego State Univ., CA. Dept. of Geological Sciences.
For primary bibliographic entry see Field 4B.
W88-09244

GROUND WATER RESERVOIR MANAGEMENT THROUGH ARTIFICIAL RECHARGE--FACT OR FANTASY,
For primary bibliographic entry see Field 4B.
W88-09245

GROUND WATER RECHARGE IN SASKATCHEWAN--A HISTORICAL REVIEW AND AN ASSESSMENT OF POTENTIAL,
Saskatchewan Univ., Saskatoon. Coll. of Engineering.
For primary bibliographic entry see Field 4B.
W88-09246

ARTIFICIAL RECHARGE POTENTIAL IN THE FRESNO AND MADERA IRRIGATION DISTRICTS,
For primary bibliographic entry see Field 4B.
W88-09247

PRESENT-DAY MODELING OF SOURCE AND DIRECTION OF GROUND WATER MOVEMENT,
H. E. Skibitzke, and R. A. Bowen.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 95-103, 8 fig, 1 tab, 3 ref.

Descriptors: *Groundwater, *Model studies, *Groundwater movement, Aquifers, Drawdown, Hydrologic budget, Wells, Computer models, Mathematical models, Darcys Law.

The advent of computer modeling of groundwater flow led to extension of the commonly used equations for the two-dimensional regime to the three-dimensional regime. This erroneous adaptation stems, in part, from the use of the steady-state formula of Darcy's Law to analyze the non-steady

state that occurs when depth is considered as a function. Movement of the free surface is the controlling feature for the source of water in the non-equilibrium case. Mathematically, this requires changing the description of the non-equilibrium equation of continuity to a nearly LaPlacian expression. Hence, the source of water is drainage at the free surface for both the equilibrium and non-equilibrium states. The energy equation is also represented by the free surface. The decline in the water table furnishes an energy source between aquifer measuring points that is proportional to the lowering of the free surface, a condition that is not accounted for by Darcy's Law as it is used in the development of two-dimensional flow equations. Thus, extended two-dimensional equations with their coincident idealizations cannot correctly analyze the source of water, as well as its direction of flow, for three-dimensional cases. (See also W88-09240) (Cassar-PTT)
W88-09252

COMPUTER CODES FOR MODELING IN CONJUNCTIVE GROUND WATER/SURFACE WATER MANAGEMENT PROGRAMS,
For primary bibliographic entry see Field 4B.
W88-09253

GROUND WATER MODELING APPLIED TO DETERMINING WELL LOCATIONS AND WELL FIELD YIELD, CERREJON COAL PROJECT, COLOMBIA, SOUTH AMERICA,
M. V. Damm, and C. R. Comstock.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 116-126, 6 fig, 3 tab, 3 ref.

Descriptors: *Water resources development, *Wells, *Groundwater availability, *Model studies, *Groundwater development, *Well yield, Cerrejon Coal Project, Colombia, aquifers, Water supply development, Aquifer testing, Coal mining.

A finite difference groundwater model has been employed to aid in positioning wells and in determining yield estimates for a well field in an alluvial stream-aquifer system in northern Colombia. This well field will provide a potable water supply for the Cerrejon Coal Project--a multibillion dollar mine that will produce 15 million metric tons of coal per year. Field data collected prior to 1982 were used to define tentative well locations and develop a preliminary computerized groundwater model. These locations were evaluated by a systematic trial and error approach with the aid of the model. For a selected number of wells with an estimated and realistic discharge, the model simulated 20 years of operation. Increasing numbers of wells at wide spacings were operated in the model until drawdowns became excessive. These analyses indicated the stream-aquifer system could support a maximum of 15 wells at 100 gpm each. Field work for installing and testing the wells was accomplished during June through September 1982. Installation of 20 wells was planned (six as backup), but the field program showed the aquifer to be less extensive than anticipated. Therefore, only 18 wells were constructed. Four wells were subjected to aquifer tests and 11 were tested for performance. Information from the 1982 field program was used to develop revised model input for a redetermination of well field yield. The trial and error approach, as described above, was employed to determine that yield. This modeling indicates that only 11 widely spaced wells should be operated at any given time over the long term (20 years), with a sustained yield of approximately 1100 gpm--a significant reduction from the estimate of the old data base. Sensitivity analyses were performed to determine the effect of some simplifications employed in the modeling. These analyses indicate that the long-term yield estimate is probably conservative. (See also W88-09240) (Author's abstract)
W88-09254

MANAGEMENT OF DECLINING GROUND WATER LEVELS IN PART OF EASTERN WASHINGTON,
For primary bibliographic entry see Field 4B.
W88-09255

GROUND WATER MANAGEMENT: SAN DIEGO STYLE,
San Diego County, CA.
For primary bibliographic entry see Field 4B.
W88-09259

CONTROLS OVER INTERSTATE TRANSFERS OF GROUND WATER POST-SPORHASE: STATE AND FEDERAL OPTIONS,
For primary bibliographic entry see Field 6E.
W88-09263

FORGING THE NEW WATER LAW: PUBLIC REGULATION OF PROPRIETARY GROUND WATER RIGHTS,
McCutcheon, Doyle, Brown and Enersen, San Francisco, CA.
For primary bibliographic entry see Field 6E.
W88-09264

DEVELOPMENT OF A PLAN TO PROTECT LOS ANGELES' SAN FERNANDO VALLEY GROUND WATER BASIN FROM INDUSTRIAL CONTAMINATION,
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 5G.
W88-09267

GROUND WATER MANAGEMENT MODEL FOR DESERT AQUIFERS,
Ohio Univ., Athens. Dept. of Geological Sciences.
M. U. Ahmad, and M. S. Beljin.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 263-267, 2 fig.

Descriptors: *Geohydrology, *Model studies, *Aquifers, *Deserts, Arid lands, Saudi Arabia, Libya, Wells.

Large basins and well fields in Libya and Saudi Arabia were modeled to predict the rate of recovery and to improve water resource management. Essential information (accurate water levels and recharge or discharge data) for modeling is often difficult and expensive to acquire. Suggestions for an adequate data base involve drilling exploration and production wells over a widely scattered area. These should be pump-tested for 5-10 days to determine preliminary aquifer parameters and water quality. These data should be used to construct a numerical identification model, using a three-dimensional model wherever possible. The model and other techniques should be used to help locate well fields. Then well fields can be constructed and pumped for irrigation or municipal use. In addition, a network of shallow and deep observation wells should be constructed and monitored. Models should be updated yearly, using data obtained from monitoring and observation wells. (See also W88-09240) (Cassar-PTT)
W88-09269

INFLUENCE OF VERTICAL VARIATIONS IN LITHOLOGY ON A MATHEMATICAL MANAGEMENT MODEL FOR THE OGALLALA AQUIFER, TEXAS COUNTY, OKLAHOMA,
For primary bibliographic entry see Field 4B.
W88-09270

USE OF A COMPUTER MODEL FOR GROUND WATER MANAGEMENT, EASTERN SAN JOAQUIN COUNTY, CALIFORNIA,
Brown and Caldwell, Sacramento, CA.
For primary bibliographic entry see Field 4B.
W88-09271

INCORPORATION OF PREDICTED FUTURE CLIMATIC EFFECTS INTO SIMULATIONS FOR GROUND WATER RESOURCE EVALUATIONS,
For primary bibliographic entry see Field 2A.
W88-09272

DIGITAL ANALYSIS OF WATER MOVEMENT, WATER QUALITY AND LAND USE EFFECTS IN A STREAM-AQUIFER SYSTEM,
Geological Survey, Tacoma, WA.
For primary bibliographic entry see Field 2E.
W88-09273

WATER RESOURCE MANAGEMENT PLANNING CRITERIA FOR VASHON/MAURY ISLAND, WASHINGTON: A CASE STUDY,
For primary bibliographic entry see Field 4B.
W88-09275

GROUND WATER SAFE YIELD USING LOW-FLOW FREQUENCY ANALYSIS,
Boyle Engineering Corp., San Diego, CA.
For primary bibliographic entry see Field 4B.
W88-09277

EVIDENTIARY CONSIDERATIONS RELATED TO THE USE OF GROUND WATER MODELS IN LITIGATION,
Moses, Wittemyer, Harrison, and Woodruff, Boulder, CO.
For primary bibliographic entry see Field 6E.
W88-09280

RECOMMENDED REVISIONS FOR SAN DIEGO COUNTY'S RURAL GROUND WATER POLICY AND GROUND WATER INVESTIGATION PRACTICES,
For primary bibliographic entry see Field 4B.
W88-09281

PROCEEDINGS OF THE SIXTH NATIONAL SYMPOSIUM AND EXPOSITION ON AQUIFER RESTORATION AND GROUND WATER MONITORING.
National Water Well Association, Dublin, OH.
For primary bibliographic entry see Field 5G.
W88-09283

TECHNICAL ENFORCEMENT GUIDANCE DOCUMENT FOR GROUND-WATER MONITORING SYSTEMS,
Environmental Protection Agency, Washington, DC. Office of Waste Programs Enforcement.
For primary bibliographic entry see Field 6E.
W88-09284

COMPARISON OF THE EFFECTS OF ROTARY WASH AND AIR ROTARY DRILLING TECHNIQUES ON PUMPING TEST RESULTS,
Battelle Pacific Northwest Labs., Richland, WA.
R. Schalla.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 7-26. 6 fig, 3 tab, 20 ref.

Descriptors: *Drilling, *Transmissivity, *Pumping tests, *Monitoring wells, *Groundwater monitoring, Monitoring, Aquifer characteristics, Bedrock, Monitoring, Data interpretation, Aquifers, Groundwater management, Groundwater.

Pumping tests were performed on monitor wells distributed in a 1 sq mile area. Thirty-five of the 41 wells were screened in fractured dolomite (bedrock), and 6 wells were screened in an overlying layer of sand and gravel. The results of 63 sets of pumping test data revealed four trends. The first trend may indicate that mud invasion of pores is less detrimental in sand than in fractures; however, it is more likely that a fundamental difference exists between the average transmissivity of granular porous media (sand and gravel) and fractured dolomite. The second trend supports the hypothesis that rotary wash methods reduce transmissivities

by filling fractures that cannot be cleaned out of 2-in-diameter wells during development. The third trend indicates that larger diameter boreholes encounter more fractures or that larger diameter casings permit the use of more effective development techniques. The fourth trend suggests a limit to the benefits of larger (6-in-diameter) wells in low-yield formations, but may merely reflect that the small sampling is unrepresentative of the formation. Based on these trends, the drilling method (i.e., air versus rotary wash), the geologic medium, and the diameter of the monitor well or borehole significantly influence whether pumping test data are representative of aquifer conditions before drilling. The drilling method has significant influence, but the diameter of the monitor well appears to have the most influence. (See also W88-09283) (Author's abstract)
W88-09285

INSTALLATION OF MULTI-LEVEL MONITORING WELLS IN A FRACTURED ROCK MEDIA,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
For primary bibliographic entry see Field 7A.
W88-09286

ARE HUMID AREA MONITORING CONCEPTS APPLICABLE TO ARID LANDS,
Schmidt (Kenneth D.), Fresno, CA.
For primary bibliographic entry see Field 7A.
W88-09287

COMPARISON OF VADOSE MONITORING PROCEDURES,
Alabama Univ., University.
J. Ball, and D. M. Coley.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 52-61. 3 fig, 4 tab, 4 ref.

Descriptors: *Vadose water, *Drilling, *Monitoring wells, *Groundwater monitoring, *Groundwater pollution, *Lysimeters, Comparison studies, Performance evaluation, Economic aspects, Aquifers, Groundwater, Water supply, Groundwater management, Monitoring, Construction.

This paper compares the construction methods, operating techniques, and production of well type vadose zone monitoring systems to a commercially available porous cup pressure/vacuum lysimeter. The purposes of the well type units were to offer a method that could use typical monitoring well materials, be constructed by monitoring well techniques, and most importantly provide sufficient sample volume to determine a number of waste constituent tests. Three well type units were installed to determine the effects of screen area, screen depth and vacuum on sampling rate. These variable were compared to the sampling rate of a commercially available pressure/vacuum lysimeter at the same effective depth and vacuum. Installation techniques, construction details and cost information are presented. (See also W88-09283) (Author's abstract)
W88-09288

EVALUATING FLUSHING AS A REMEDIAL ALTERNATIVE USING SOIL COLUMN TESTS,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
For primary bibliographic entry see Field 7B.
W88-09289

USE OF STATIC SOIL VAPOR COLLECTORS TO IDENTIFY SUBSURFACE CONTAMINATION IN SOUTHERN CALIFORNIA GROUND WATER BASINS,
Mills (William B.) and Associates, Placentia, CA.
For primary bibliographic entry see Field 5A.
W88-09290

ALTERNATIVE METHOD OF LYSIMETER AND SILICA FLOUR PACK PLACEMENT IN DEEP BOREHOLES,
LeRoy Crandall and Associates, Glendale, CA.
R. J. Brose, R. W. Shatz, and T. M. Regan.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 88-95. 1 fig, 11 ref.

Descriptors: *Boreholes, *Lysimeters, *Groundwater monitoring, *Monitoring wells, *Groundwater pollution, *Sampling devices, Analytical models, Porus media, Silica flour packs, Performance evaluation, Aquifers, Drilling, Groundwater.

A useful technique has been developed to assist in the placement of a silica flour pack adjacent to a tube or cup-type vacuum lysimeter at depth in boreholes. Manufacturing recommendations for silica flour pack placement do not assure a uniform or uncontaminated silica flour pack adjacent to the porous lysimeter filter in deep (greater than 20 feet) boreholes. The authors' method, which consists of freezing a mixture of silica flour and distilled water in a mold containing the lysimeter prior to placement in the borehole, allows for accurate centering of the lysimeter, and ensures a minimum and isotropic silica flour pack adjacent to the porous lysimeter, which can be visually verified prior to placement. The method reduces the potential for both flour pack contamination during placement, and lysimeter clogging during subsequent use. The frozen flour pack/lysimeter combination provides easy installation in deeper boreholes. Lysimeter operation and sample acquisition are facilitated within 24 hours following lysimeter placement. The method does not damage the porous filter of the lysimeter, and does not affect the ability of the lysimeter or tubing to hold a vacuum. Successful use of the method has enabled installation of lysimeter and transfer vessel equipment to depths of 45 feet. (See also W88-09283) (Author's abstract)
W88-09291

EVOLUTION AND ADEQUACY OF GROUND WATER MONITORING NETWORKS AT HAZARDOUS WASTE DISPOSAL FACILITIES IN ILLINOIS,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 7A.
W88-09292

DESIGN OF A MONITORING NETWORK TO DETECT THE EFFECTS OF LAND USE ON GROUND WATER QUALITY AND DESCRIBE THE CONTAMINANT FLOW SYSTEM IN THE PIEDMONT OF NORTH CAROLINA,
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7A.
W88-09293

USE OF PRESSURE DIFFERENTIAL MEASUREMENTS TO MAP CHEMICAL-QUALITY VARIATIONS IN A VARIABLE-DENSITY GROUND WATER SYSTEM,
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 7A.
W88-09294

APPLYING THREE DIMENSIONAL GROUND WATER MODELING TO MONITORING NETWORK DESIGN: A CASE HISTORY,
Camp, Dresser and McKee, Inc., Detroit, MI.
For primary bibliographic entry see Field 7A.
W88-09295

IMPACT OF THE CHANGED RCRA REGULATORY ENVIRONMENT UPON FACILITIES WITH GROUND WATER MONITORING,
Geraghty and Miller, Inc., Washington, PA.
For primary bibliographic entry see Field 6E.
W88-09296

EXPECTING THE UNEXPECTED,
Oklahoma State Univ., Stillwater. Dept. of Geology.
For primary bibliographic entry see Field 7A.
W88-09298

EFFECTS OF FILTRATION METHOD AND SAMPLING DEVICES ON INORGANIC CHEMISTRY OF SAMPLED WELL WATER,
RMT, Inc., Madison, WI.
For primary bibliographic entry see Field 5A.
W88-09299

FIELD EVALUATION OF GROUND WATER SAMPLING DEVICES FOR VOLATILE ORGANIC COMPOUNDS,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
For primary bibliographic entry see Field 5A.
W88-09300

GROUND WATER SAMPLING WITHOUT WELLS,
Montgomery (J.M.) Consulting Engineers, Inc., Irvine, CA.
For primary bibliographic entry see Field 5A.
W88-09302

USE OF ONSITE ANALYTICAL LABORATORY INSTRUMENTATION TO DETERMINE THE EXTENT OF CONTAMINATION AT A HAZARDOUS WASTE SITE,
Camp, Dresser and McKee, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5A.
W88-09303

RAPID GROUND WATER ASSESSMENT USING A MOBILE LABORATORY,
O.H. Materials Corp., Findlay, OH.
For primary bibliographic entry see Field 5A.
W88-09304

RATIONALE FOR FILTRATION OF GROUND WATER SAMPLES,
Geraghty and Miller, Inc., Syosset, NY.
For primary bibliographic entry see Field 7B.
W88-09305

SHOULD GROUND WATER SAMPLES FROM MONITORING WELLS BE FILTERED BEFORE LABORATORY ANALYSIS, YES AND NO,
New Jersey Dept. of Environmental Protection, Trenton.
For primary bibliographic entry see Field 5A.
W88-09306

POSITIVE ASPECTS OF SAMPLE FILTRATION,
Jordan (Edward C.) Co., Inc., Portland, ME.
For primary bibliographic entry see Field 5A.
W88-09307

SCREEN LENGTH SELECTION FOR USE IN DETECTION MONITORING WELL NETWORKS,
Giddings (Todd) and Associates, Inc., State College, PA.
For primary bibliographic entry see Field 7A.
W88-09308

RATIONALE FOR SCREEN LENGTH SELECTION AND PLACEMENT,
Environmental Protection Agency, Denver, CO. Region VIII.
For primary bibliographic entry see Field 7A.
W88-09309

HOW DRILLING FLUIDS AND GROUTING MATERIALS AFFECT THE INTEGRITY OF GROUND WATER SAMPLES FROM MONITORING WELLS,

Geraghty and Miller, Inc., Lawrence, KA.
For primary bibliographic entry see Field 7B.
W88-09311

EFFECTS OF GROUTS, SEALANTS, AND DRILLING FLUIDS ON THE QUALITY OF GROUND-WATEK SAMPLES,
Environmental Protection Agency, Washington, DC. Office of Waste Programs Enforcement.
For primary bibliographic entry see Field 7B.
W88-09312

ELEMENTS OF NATURAL ADAPTATION OF NATIVE BACTERIAL MACROCOSMS FOLLOWING ORGANIC CONTAMINATION,
Groundwater Technology, Inc., Chadds Ford, PA.
For primary bibliographic entry see Field 5C.
W88-09313

CHEMICAL INJECTION AND GROUND WATER RECOVERY TECHNIQUES FOR IN-SITU REMEDIATION OF A SUBSURFACE FORMALIN RELEASE - A CASE HISTORY,
Monsanto Polymer Products Co., Bridgeport, NJ. Delaware River Plant.
For primary bibliographic entry see Field 5G.
W88-09314

APPLICATION OF MICROCOSM TECHNOLOGY TO STUDY THE BIODEGRADATION POTENTIAL OF A SUBSURFACE ALLUVIAL MATERIAL EXPOSED TO SELECTED PETROLEUM HYDROCARBONS,
Engineering Enterprises, Inc., Norman, OK.
For primary bibliographic entry see Field 5B.
W88-09315

GROUND WATER RESTORATION USING BIORECLAMATION IN FRACTURED PENNSYLVANIAN BEDROCK,
O.H. Materials Corp., Findlay, OH.
For primary bibliographic entry see Field 5G.
W88-09316

FIXED-FILM BIOREACTOR TO TREAT TRICHLOROETHYLENE-LADEN WATERS FROM INTERDICTION WELLS,
Oklahoma Univ., Norman. Environmental and Ground Water Inst.
For primary bibliographic entry see Field 5D.
W88-09317

FIELD DEMONSTRATION OF ENHANCED BIORECLAMATION,
FMC Corp., Princeton, NJ. Aquifer Remediation Systems.
For primary bibliographic entry see Field 5G.
W88-09318

GRAVITY FLOW HORIZONTAL DRAINS UTILIZED FOR IN-PLACE REMEDIATION,
Blasland and Bouck Engineering, Syracuse, NY.
For primary bibliographic entry see Field 5G.
W88-09319

MONITORING AND RECOVERY OF FREE HYDROCARBONS,
Engineering Science, Cleveland, OH.
For primary bibliographic entry see Field 5G.
W88-09320

WATER SUPPLY CONTAMINATION CLEAN-UP IN MASSACHUSETTS,
Massachusetts Dept. of Environmental Quality Engineering, Boston.
For primary bibliographic entry see Field 5G.
W88-09321

RECOVERY OF PETROLEUM PRODUCT FROM A HIGHLY PERMEABLE AQUIFER UNDER THE EFFECTS OF MUNICIPAL WATER SUPPLY WELLS,
IT Corp., Pittsburgh, PA.
J. A. Broscious, V. Batu, and M. C. Plautz.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 493-509. 5 fig, 3 ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Water table, *Cleanup operations, *Waste recovery, *Oil spills, *Groundwater monitoring, *Pumping, *Case studies, *Hydrocarbons, *Monitoring wells, *Aquifers, *Water supply systems, Drinking water, Temporal distribution, Geohydrology, Hydrology, Groundwater, Path of pollutants.

This paper presents important aspects of groundwater pollution cleanup experienced in a case study under critical conditions. In an oil spill area, the water table fluctuated over a relatively wide range (approximately + or - 1.0 foot) daily due to local production wells situated approximately 400 feet from the spill site. A data base was developed that established the interrelationship between fluctuations in water table elevations with the thickness of product evidenced over an extended period of time. The hourly data obtained at the various monitoring and recovery wells showed that the measured product thicknesses were a function of the pumping rate scenarios of the production wells and that the greatest product thicknesses were found in a falling water table condition. The calculation procedures utilized in the estimation of recoverable product volume are discussed. Some practical guidelines are also presented, including: calculation of maximum allowable downtime for protection of municipal well water supplies in the event of pumping outages at product recovery wells; and minimization of project costs through maximization of product recovery efficiency, automation of depression pumping equipment for remote system monitoring, and rapid determination of the effects of dynamic hydrogeological conditions. (See also W88-09283) (Author's abstract)
W88-09322

ASSESSMENT AND REMEDIATION OF VOLATILE ORGANIC CONTAMINATION IN A SHALLOW ALLUVIAL AQUIFER,
Woodward-Clyde Consultants, Rockville, MD.
For primary bibliographic entry see Field 5G.
W88-09324

REMEDIATION OF SUBSURFACE CONTAMINATION FROM VOLATILE ORGANIC COMPOUNDS USING SOIL GAS EXTRACTION TECHNIQUES,
Woodward-Clyde Consultants, Solon, OH.
For primary bibliographic entry see Field 5G.
W88-09326

LARGE-SCALE HIGH-EFFICIENCY AIR STRIPPER AND RECOVERY WELL NETWORK FOR REMOVING VOLATILE ORGANIC CHLOROCARBONS FROM GROUND WATER,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
For primary bibliographic entry see Field 5G.
W88-09328

CASE HISTORY - TREATMENT OF CONTAMINANT GROUND WATER USING ELEVATED TEMPERATURE AIR STRIPPING,
Rexnord, Inc., Milwaukee, WI. Corporate Research and Development Group.
For primary bibliographic entry see Field 5G.
W88-09329

INTERCEPTOR TRENCHES FOR POSITIVE GROUND WATER CONTROL,
Union Carbide Corp., Port Lavaca, TX. Polyofins Div.
For primary bibliographic entry see Field 5G.
W88-09330

APPLICATION OF A GROUND-WATER-QUALITY MANAGEMENT MODEL TO THE EQUUS BEDS AQUIFER IN KANSAS,
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 5G.
W88-09331

CHARACTERIZATION OF GROUND WATER CONTAMINATION ASSOCIATED WITH COAL MINES IN WEST VIRGINIA,
Camp, Dresser and McKee, Inc., Denver, CO.
For primary bibliographic entry see Field 5B.
W88-09332

CONTAMINANT TRANSPORT MODELING FOR A PROPOSED HAZARDOUS WASTE SITE,
Harza Engineering Co., Chicago, IL.
For primary bibliographic entry see Field 5B.
W88-09333

GROUNDWATER MODELS FOR MOUNTAIN SLOPES,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
K. Okunishi, and T. Okimura.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 265-285, 17 fig, 48 ref.

Descriptors: *Mass movement, *Mass wasting, *Groundwater movement, *Hydraulic models, *Mountains, *Slopes, *Slope stability, Geohydrology, Flow velocity, Creep, Avalanches, Landslides, Seepage, Pore pressure, Hydraulic properties.

Saturated and unsaturated throughflow, following infiltration of rainfall, may result in a perched water table. Deeper groundwater occurs in the underlying substrate which may be a weathered saprolite, a sedimentary deposit, or bedrock. Hydraulic properties of these materials depend on their pore properties and on fracture characteristics, and as a result groundwater occurrence in mountain regions is highly variable and difficult to generalize. The mechanical stability of a slope is affected by the reduction of effective normal stress caused by positive pore pressures. An additional mechanical influence occurs when groundwater flow is concentrated and seepage velocities are high. The shear strength of soil is reduced by lateral translocation of soil matrix, and by leaching of cementing material. A range of mass movement types exist, but all are strongly affected by groundwater conditions. A convenient classification is based on speed of motion, and involves the following main types: (1) Creep displacement. After an initial deep-seated failure, landslide blocks may creep progressively on the shear plane at rates controlled by the stress-strain rate behavior of the soil, and the pore water pressure at the shear surface; (2) Landslides. Most failures which involve marked downslope displacement of the slipped mass reflect extreme groundwater conditions in heavy rain or rapid snowmelt; and (3) Debris avalanches, debris flows, earth flows and mudflows. These are multiphase flows of solid, liquid, and gas (when air entrapment occurs). When a rigid sliding mass becomes a flow, fluidization involves a large energy conversion from the released potential energy, some of which may become a debris avalanche. The general principles involved in the analysis of groundwater flow are outlined. Some methods developed in Japan for the prediction of slope failure due to extreme groundwater conditions in mountain areas have required the development of simulation models, such as the tank model that has been used (sometimes in a modified form) to predict superficial slides and debris flow, to simulate landslide stimulation by confined fissure water, to simulate geological structures as a control of groundwater regime and rockslide activity, and to simulate the relationship between groundwater regime and creep displacement. (See also W88-09334) (Lantz-PTT)
W88-09342

ENGINEER'S MANUAL FOR WATER WELL DESIGN.
Moss (Roscoe) Co., Los Angeles, CA.
For primary bibliographic entry see Field 8A.
W88-09353

WATER WELL HANDBOOK.
Missouri Water Well and Pump Contractors Association, Belle, MO.
For primary bibliographic entry see Field 8A.
W88-09354

DESIGN AND CONSTRUCTION OF WATER WELLS: A GUIDE FOR ENGINEERS.
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 8A.
W88-09356

PROCEEDINGS OF THE 8TH NATIONAL GROUND WATER QUALITY SYMPOSIUM: 'ANATOMY OF SUPERFUND'.
National Water Well Association, Dublin, OH.
For primary bibliographic entry see Field 5G.
W88-09374

HAND DRILLED WELLS: A MANUAL ON SITING, DESIGN, CONSTRUCTION AND MAINTENANCE.
Rwegarulila Water Resources Inst., Dar es Salaam (Tanzania).
B. Blankwaardt.
Rwegarulila Water Resources Inst., Dar es Salaam, Tanzania. 1984. 132 p, 137 fig, 7 tab, 24 ref, 7 append, 6 annexes.

Descriptors: *Wells, *Well construction, *Water supply development, *Drilling, Geohydrology, Site selection, Pumps, Maintenance, Surveys, Developing countries.

In developing countries with large rural populations, the need for new water supply systems, is an ever-increasing necessity. Hand drilling wells is often the most economical and technically viable method for providing water. This manual is constructed in six parts. The first part - Chapter 1 - is an introduction to the subject. In the second part Chapters 2 and 3 - the most necessary hydrogeological theory is given. Part three which includes Chapters 4 and 5, deals with site investigation and the criteria for approving a site for construction of a well. In part four - Chapter 6 - the design of the well is discussed, and in part five - Chapters 7 to 11 - the actual construction of the well including the installation of a hand pump. In the last part - Chapter 12 - a possible approach toward the maintenance of pumps and wells is indicated. In order to keep the size of the chapters on site investigation and well drilling operations limited, the survey and well drilling equipment have been described in separate appendices. (Lantz-PTT)
W88-09400

HISTORY OF HYDROLOGY.
For primary bibliographic entry see Field 2A.
W88-09405

DARCY'S LAW: ITS PHYSICAL THEORY AND APPLICATION TO ENTRAPMENT OF OIL AND GAS.
M. K. Hubbert.
IN: The History of Hydrology. American Geophysical Union, Washington, DC. 1987. p 1-26, 24 fig, 19 ref.

Descriptors: *Geophysics, *Groundwater movement, *Darcys law, *Petrology, *History, Mathematical studies, Water potential, Filtration, Water pressure, Gravity flow, Aquifers, Sand aquifers, Mathematical equations.

Darcy's Law appeared in an 1856 monograph by Henry Darcy, who had been working on a modernization project at the Dijon, France, waterworks. His experiments on flow of water through sands were designed to determine the size of a sand filter required for a given volume of water per day. Starting with the primitive kinematic formula, which involved only the dimensions of length and time, the force of gravity was introduced to yield a dynamic equation expressing the potential of a fluid at a particular point. This potential is the work required to transport a unit mass of the fluid from a standard reference elevation and pressure to the elevation and pressure at the given point. At each point in a water-filled regional sandstone, there are definite potentials for water, oil, and gas, all having different values. Thus, in a regional sandstone, if the water is static, the water potential will be constant in space, whereas the equipotential surfaces for both oil and gas will be horizontal with their potentials, each decreasing upward, but with the gradient of that for gas being greater than that for oil. If the water is flowing, the water equipotential surfaces will be perpendicular to the water flowlines and essentially perpendicular to the sandstone stratum, whereas the equipotential surfaces for both oil and gas will be inclined downward in the water-flow direction, those for oil being more steeply inclined than those for gas. The exploration for oil and gas thus reduces in part to the location of those regions which have minimum potential for the respective fluids. (See also W88-09405) (Cassar-PTT)
W88-09406

DISCOVERY OF THE AQUIFERS OF THE NEW JERSEY COASTAL PLAIN IN THE NINETEENTH CENTURY.
Stockton State Coll., Pomona, NJ.
C. M. Epstein.
IN: The History of Hydrology. American Geophysical Union, Washington, DC. 1987. p 69-73, 1 fig, 2 tab, 22 ref.

Descriptors: *Potable water, *New Jersey, *Geophysics, *Aquifers, *Wells, *Coastal aquifers, History, Groundwater pollution, Stratigraphy, Coastal plains, Terminology, Water supply, Aquifer characteristics.

The New Jersey coastal plain aquifers were discovered before 1900 through the efforts of local authorities, well drillers, and the New Jersey State Geological Survey during the search for new and safe water supplies for the rapidly expanding population. George Cook, the survey's director, worked with the more than 1000 19th century well logs and began to correlate the water-bearing horizons of New Jersey. Lewis Woolman continued Cook's work by identifying most of the known aquifers and correlating them across the coastal plain. G. N. Knapp, H. Poland, and survey director H. B. Kummel applied modern hydrogeologic nomenclature to Woolman's identification. The hazards to groundwater quality had been recognized before 1900. Water quality and quantity problems recognized by Cook and others included surface contaminant infiltration, salt water intrusion, naturally non-potable groundwater, and well drawdown interference with neighboring wells and groundwater diversion rights. A table lists the terminology of the current U. S. Geological Survey aquifer names and their historical names as recorded in publications in 1889, 1893, 1897, 1903, and 1909. Current names include Kirkwood-Cohansey, Rio Grande, Atlantic City, 800-ft Sand, Piney Point, Vincentown, Redbank, Mt. Laurel-Wenonah, Englishtown, and Potomac-Raritan-Magothy. (See also W88-09405) (Cassar-PTT)
W88-09409

HISTORY OF THOUGHT ON THE ORIGIN OF SUBSURFACE SEDIMENTARY BRINES.
Louisiana State Univ., Baton Rouge. Dept. of Geology.
For primary bibliographic entry see Field 2K.
W88-09411

R. E. MOORE AND YOLO LIGHT CLAY.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2G.
W88-09413

CHARLES SUMNER SLICHTER--AN ENGINEER IN MATHEMATICIAN'S CLOTHING.
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
H. F. Wang.
IN: The History of Hydrology. American Geophysical Union, Washington, DC. 1987. p 103-112, 15 fig, 20 ref.

Descriptors: *Geophysics, *Groundwater movement, *Hydrology, *Dispersion, History, Well hydraulics, Mathematical studies, LaPlace equation, Darcys law, Solute transport, Schlichter, Charles Sumner, Electrolytes.

Charles Sumner Slichter (1864-1946) was an applied mathematician who made important contributions to groundwater hydrology between 1894 and 1912. His most significant scientific paper, 'Theoretical Investigation of the Motion of Ground Waters,' was published by the U. S. Geological Survey in 1899. Slichter expressed the analogy of groundwater flow to heat and electrical conduction, as well as to ideal fluid flow. He combined Darcy's law and continuity to produce Laplace's equation under the assumption of homogeneity. He then used the methods of classical potential theory to describe well interference and the effects of irrigation ditches. The seminal value of his work was explicitly acknowledged by M. K. Hubbert in 1940, although Hubbert was critical of the use of a velocity potential. Slichter conducted numerous field studies throughout the country, including California, the Rio Grande Valley, Long Island, and southwestern Kansas. He determined flow velocities by injecting electrolytes in wells and observing their appearance in other wells. He also conducted laboratory experiments and concluded that dispersion rather than diffusion was responsible for the distribution of the solute. Thus, Slichter may be considered to have conducted the first research into contaminant transport by groundwater. (See also W88-09405) (Cassar-PTT)
W88-09414

SAMPLING GROUNDWATER MONITORING WELLS: SPECIAL QUALITY ASSURANCE AND QUALITY CONTROL CONSIDERATIONS.
IT Corp., Austin, TX.
For primary bibliographic entry see Field 5A.
W88-09425

GROUNDWATER SAMPLING.
Satterthwaite Associates, Inc., West Chester, PA.
For primary bibliographic entry see Field 5A.
W88-09427

PERMEABILITY AND GROUNDWATER CONTAMINANT TRANSPORT.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5B.
W88-09434

GLOSSARY.
Woodward-Clyde Consultants, Denver, CO.
For primary bibliographic entry see Field 5B.
W88-09435

MEASUREMENT OF THE HYDRAULIC CONDUCTIVITY OF FINE-GRAINED SOILS.
Texas Univ. at Austin. Center for Electromechanics.
For primary bibliographic entry see Field 7B.
W88-09436

ROCK PERMEABILITY OR HYDRAULIC CONDUCTIVITY - AN OVERVIEW.
Law Engineering Testing Co., Marietta, GA.
G. F. Sowers.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 65-83, 9 fig, 1 tab, 8 ref.

Descriptors: *Permeability, *Rocks, *Hydraulic conductivity, *Groundwater, Porosity, Rock joints, Geohydrology, Mathematical studies, Flow profiles.

The water transmission characteristics of rock formations are far more variable than those of most soils. The flow conduits include: (1) primary porosity, the voids between mineral grains or fragments; (2) genetic porosity, voids which developed within the rock during its formation; and (3) secondary porosity, the joints, shear zones, and other cracks that formed subsequent to deposition. The porosity changes over time as the voids both fill up and become enlarged. The flow patterns are complex, with tortuous paths between the different forms of porosity. Laminar and turbulent flow occur simultaneously, depending on void size and energy gradients. The flow can be characterized by a variable pseudopermeability coefficient, k sub p. Laboratory tests are useless unless the sample size is an order of magnitude larger than the secondary porosity spacing. Field measurements in bore holes or an evaluation of subregional discharge is necessary for making a realistic evaluation of k sub p of rock aquifers. There are likely to be large variations in k sub p depending on location, time, and changes in the groundwater environment. (See also W88-09434) (Author's abstract)
W88-09437

PERMEABILITY OF SOILS USING CONTAMINATED PERMEANT,
Woodward-Clyde Consultants, San Francisco, CA.
For primary bibliographic entry see Field 5B.
W88-09439

LOW-GRADIENT PERMEABILITY TESTING OF FINE-GRAINED MARINE SEDIMENTS,
Rhode Island Univ., Kingston. Dept. of Ocean Engineering.
A. J. Silva, J. R. Hetherman, and D. I. Calnan.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 121-136, 9 fig, 23 ref. Office of Naval Research Contract N00014-76-C-0226 and DOE Contract 13-2561.

Descriptors: *Groundwater movement, *Marine sediments, *Permeability, *Soil texture, Pore pressure, Flow profiles, Testing procedures, Pressure head, Temperature, Porosity.

A back-pressured consolidation system has been modified to allow direct permeability measurements of fine-grained, low-permeability soils and marine sediments. The system allows for high back pressures (3100 kPa), axial flow in either direction with fresh or saltwater permeants, constant head tests at low gradients, and falling head tests. Low-gradient tests are conducted with a static head or with falling heat methods, and high gradient are maintained with a sensitive air-pressure control system. The unit can also be used to study temperature effects in the range of 2 to 200 C. The apparatus and procedures are described, and a summary of test results is presented. Results of low-gradient constant head tests have agreed very well with falling head tests. Coefficient of permeability values in the range of 10 to the -6th power to 10 to the -9th power cm/sec have been measured. No evidence of a threshold gradient has been indicated at higher void ratios approximating in situ conditions, but small threshold gradients were observed at relatively low void ratios. (See also W88-09434) (Author's abstract)
W88-09440

CORRELATIVE MEASUREMENTS OF PORE SIZE DISTRIBUTION AND PERMEABILITY IN SOILS,
CH2M, Inc., Portland, OR.
For primary bibliographic entry see Field 2G.
W88-09441

EVALUATING THE SATURATED AND UNSATURATED HYDRAULIC CONDUCTIVITY OF SOILS,
Illinois State Geological Survey Div., Champaign.
A. Elzeftawy, and K. Cartwright.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 168-181, 6 fig, 2 tab, 17 ref. Illinois Water Resources Research Center Project A-097-ILL.

Descriptors: *Soil water, *Hydraulic conductivity, *Saturated soil, *Saturated flow, *Unsaturated flow, *Aeration zone, Mathematical studies, Soil texture, Pore size, Mathematical equations, Porosity.

A method of calculating the saturated and unsaturated hydraulic conductivities of soils and similar porous materials based on the pore size distribution was shown to predict the experimentally measured values adequately. For coarse-textured soil materials or materials with a relatively narrow range of pore size, only one matching factor is required to calculate the hydraulic conductivity-water content relation accurately enough for many purposes; however, for fine-textured soil materials with a wide range of pore size distribution, two or more matching factors at a water content in the 0.3 to 0.4 bar range may be needed to obtain a useful evaluation for the unsaturated hydraulic conductivity. (See also W88-09434) (Author's abstract)
W88-09443

PREDICTIVE TOOLS FOR CONTAMINANT TRANSPORT IN GROUNDWATER,
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 5B.
W88-09445

COMPUTER SIMULATION OF MOVEMENT OF DIMP-CONTAMINATED GROUNDWATER NEAR THE ROCKY MOUNTAIN ARSENAL, COLORADO,
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 5B.
W88-09446

ATTENUATION OF RADIONUCLIDES AND TOXIC ELEMENTS BY IN SITU SOILS AT A URANIUM TAILINGS POND IN CENTRAL WYOMING,
D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA.
For primary bibliographic entry see Field 5B.
W88-09447

PREPARATION OF A BEDROCK RIFS (BRIFS) ALLOWS FOR UNPREDICTABLE FLOW IN FRACTURED ROCK,
Quest Environmental Sciences, Inc., Manchester, NH.
D. Woodhouse, and K. A. Cichon.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 405-422, 4 fig.

Descriptors: *Geohydrology, *Bedrock, *Geologic fractures, *Test wells, *Path of pollutants, Groundwater recharge, Landfills, Groundwater movement, Project planning, Mapping, Road construction.

Remedial investigation/Feasibility Study (RIFS) Work Plans should be flexible enough to allow for studying unpredictable flow through fractured rock. When prior investigations are limited or absent, RI's should be phased as follows: the first phase should decide what should be monitored, and the second phase should install monitoring systems tailored to probable pathways. An RIFS study was conducted on a landfill located on a mountain in southern New England. A high probability of contaminant migration to the northwest was demonstrated. A surface water connection was also apparent to the northwest since the unnamed tributary flows through this area and is clearly degraded by leachate. The potential also exists for contamination migration to the northeast and southeast of the landfill. Structural mapping documented three regional fracture/joint sets. Fracture sets in roadcuts, outcrops, and stream cuts were observed to seep indicating that, at the surface at least, they were hydraulically conductive. Where the fracture sets were open and in the presence of a gradient, flow on a macroscale was potentially radial from the landfill. Flow on a microscale would be controlled by the fracture sets. The monitoring system was not set up to evaluate flow by this fracture mechanism. Facilities should be designed to answer specific questions. The original intent of the monitoring system was to supplement existing wells and emulate performance of residential wells which were open boreholes. (See also W88-09477) (Geiger-PTT)
W88-09500

STRESS-RELIEF FRACTURE CONTROL OF GROUND-WATER MOVEMENT IN THE APPALACHIAN PLATEAUS,
Kentucky Geological Survey, Lexington.
J. A. Kipp, and J. S. Dinger.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 423-438, 13 fig, 2 tab, 10 ref. USGS Cooperative agreement No. 14-08-0001-A0015.

Descriptors: *Geohydrology, *Geologic fractures, *Groundwater movement, *Model studies, *Coal mining, Kentucky, Test wells, Bedrock, Evapotranspiration, Permeability coefficient, Water quality, Stress.

A portion of the Kentucky Geological Survey project in the Eastern Kentucky Coal Field documents groundwater conditions in a drainage basin before, during, and after mining. The goals of this research are to develop a conceptual model of groundwater flow for small basins and to determine the effects of mining and reclamation on local groundwater flow conditions and water quality. A portion of the project is being conducted in the Wolfpen Branch area in northwestern Knott County. Before mining commenced, the study area contained a first-order stream draining approximately 185 acres of relatively undisturbed second-growth timber. Shortly before mining began, 13 observation wells were installed at four sites within the basin. The well sites were located so that two or three wells could be completed into each water-bearing zone from different topographic positions within the basin, and such that the wells would monitor the same stratigraphic units in the valley bottom, valley walls, and the core of the ridge. Groundwater flow in the basin is complex. Within the interiors of the hills, water is stored and transmitted in intergranular pore spaces of the predominantly sandstone bedrock. These rocks are saturated, but wells produce little water. Lithologic cores indicate that saturated sandstone zones are separated by relatively impermeable claystone units associated with major coal seams, which limit the vertical movement of water. These confining layers cause lateral flow to the hillsides where groundwater may discharge as springs or seeps or move vertically downward through the confining zones via secondary porosity consisting of fractures and beddings-plane openings. Bedrock wells respond quickly to rainfall events, evapotranspiration, and mining activity. This suggests high hydraulic conductivity and direct connection to infiltration from the surface. Lithologic cores indicate that secondary fracture permeability, possibly created by stress-relief fracturing, is responsible for the increased hydraulic conductivity along hillsides and valley bottom, and controls much of the shallow groundwater flow in the basin. This shallow groundwater represents the principal portion of the active groundwater flow system. (See also W88-09477) (Author's abstract)
W88-09501

STRATABOUND PATHWAYS OF PREFERRED GROUNDWATER FLOW: AN EXAMPLE FROM THE COPPER RIDGE DOLOMITE IN EAST TENNESSEE,
Oak Ridge National Lab., TN.
R. Lee, and D. Ketelle.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 439-463, 13 fig, 14 ref.

Descriptors: *Geohydrology, *Groundwater movement, *Dolomite, *Weathering, Geophysics, Groundwater recharge, Aquifer characteristics, Infiltration, Geochemistry, Tennessee.

The Copper Ridge Dolomite of the Upper Cambrian Knox Group underlies a site at Oak Ridge, Tennessee under consideration by the Department of Energy (DOE) for a below ground waste disposal facility. The Copper Ridge was studied for DOE to understand the influence of lithology on deep groundwater flow. Three facies types are distinguished which comprise laterally continuous, 1-4 m thick rock units interpreted to represent upward-shallowing depositional cycles having an apparently significant effect on groundwater flow at depth. Rock core observations indicate one of the recurring facies types is characterized by thin to medium-bedded, fine-grained dolostone with planar cryptalgal laminae and thin shaley partings. Distinctive fracturing in this facies type, that may have resulted from regional structural deformation, is considered to be responsible for weathering at depth and the development of stratabound pathways of preferred groundwater flow. In addition, geophysical data suggest that one occurrence of this weathered facies type coincides with an apparent geochemical interface at depth. Geophysical data also indicate the presence of several fluid invasion horizons, traceable outside the study area, which coincide with the unweathered occurrence of this fine-grained facies type. The subcropping of recurrent zones of preferred groundwater flow at the weathered/unweathered interface may define linear traces of enhanced aquifer recharge paralleling geologic strike. Vertical projection of these zones from the weathered/unweathered rock interface to the ground surface may describe areas of enhanced infiltration. Tests to determine the role of stratigraphic controls on groundwater flow are key components of future investigations on West Chestnut Ridge. (See also W88-09477) (Author's abstract)
W88-09502

HYDROGEOLOGIC INVESTIGATION OF WILLIAMSBURG, MASSACHUSETTS. SESSION: GLACIAL GEOLOGY/HARD ROCK,
Weston (Roy F.), Inc., West Chester, PA.
E. Storms, and W. S. Motts.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 467-490, 5 fig, 1 tab, 10 ref.

Descriptors: *Geohydrology, *Aquifer characteristics, *Groundwater recharge, *Water pollution prevention, *Safe yield, *Groundwater movement, *Water pollution control, Sodium, Groundwater management, Bedrock, Massachusetts, Groundwater pollution.

The two principal hydrogeologic units in Williamsburg, Massachusetts are crystalline bedrock formations underlying the hilly areas of town and unconsolidated sediments underlying the valleys. The unconsolidated sediments consist of glacial till, glacial outwash, and alluvium. Glacial outwash and alluvium, because of their high permeabilities, offer the greatest potential source for large groundwater supplies, whereas the bedrock has a low capacity for groundwater development except where it is highly fractured. The unconsolidated sediments range in thicknesses from 5 to 175 feet as determined by well log data and seismic refraction surveys. The two major aquifer systems in the area are the South Street and Mountain Street aquifer systems. Both are located in buried valleys containing deep trenches which intercept shallow and deep groundwater, and both contain thick and areally extensive glacial outwash and alluvium deposits that serve as reservoirs for water due to their large storage area. A transmissivity of 74,000 gpd/ft was calculated from available pump-test data of the South Street aquifer system. The Connecticut method and base-flow method were used to calculate safe yields of 0.48 mgd and 0.35 mgd, respectively, for the South Street aquifer system. A safe yield of 1.02 mgd was calculated for the Mountain Street aquifer system using the Connecticut method. The concentration of sodium, chloride, nitrate, and dissolved solids (from septic effluent and road salting) in the groundwater was estimated for the primary and secondary recharge areas. For a zoning density of 2 acres in till and bedrock terrain, the estimated annual increase of sodium is 14 ppm, and for 1 acre zoning in stratified drift (glacial outwash), the estimated annual increase of sodium is 11 ppm. Both fall below the 20-ppm health threshold recommended by the American Heart Association. Recommendations for aquifer protection include strategies for: protection from septic tanks, road salts, toxic and hazardous waste; protection of watercourses that recharge aquifer systems, and purchase of critical recharge areas. (See also W88-09477) (Author's abstract)
W88-09503

CHEMO-HYDROGEOLOGIC TRANSPORT OF CONTAMINANTS IN GLACIAL-FLUVIAL DEPOSITS: A SITE INVESTIGATION,
Camp, Dresser and McKee, Inc., New York.
For primary bibliographic entry see Field 5B.
W88-09504

USE OF SEDIMENT PERMEABILITY VARIATIONS IN THE PERFORMANCE OF PETROLEUM RECOVERY FROM GLACIAL SEDIMENTS,
Groundwater Technology, Inc., Norwood, MA.
For primary bibliographic entry see Field 5B.
W88-09505

USE AND PLACEMENT OF GROUTING AND SEALING MATERIALS,
Vermont Agency of Natural Resources, North Waterbury, VT.
For primary bibliographic entry see Field 5G.
W88-09517

COMPARATIVE VULNERABILITY TO OIL SPILLS OF BEDROCK VERSUS SAND AND GRAVEL AQUIFERS,
Maine Dept. of Environmental Protection, Augusta.
For primary bibliographic entry see Field 5C.
W88-09520

NEW BOUNDARY ELEMENT FORMULATION FOR TIME-DEPENDENT CONFINED AND UNCONFINED AQUIFER PROBLEMS,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
M. M. Aral, and Y. Tang.
Water Resources Research WRERAO, Vol. 24, No. 6, p 831-842, June 1988. 9 fig, 17 ref.

Descriptors: *Finite difference methods, *Groundwater movement, *Aquifer characteristics, Model studies, Mathematical models, Confined aquifers, Unconfined aquifers, Wells.

A new numerical time integration procedure was developed for the boundary element method (BEM) solution of time-dependent aquifer problems. The algorithm reduces the resulting finite difference time integration process to a boundary only computation, if desired, and extends the efficiency of the BEM to time-dependent problems. A selected number of interior points can also be included in the computation to increase the accuracy for problems where there is a singularity in the solution domain. This proved very effective where rapid changes in the value of the piezometric head variable in wells is expected. The method was applied to four classical porous media flow problems: (1) the Theis problem, drawdown due to constant pumping in an extensive confined aquifer; (2) an unsteady confined aquifer problem in an L-shaped aquifer; (3) an unconfined aquifer with growth of a mound due to regional recharge; and (4) extension of problem 3 to a true two-dimensional case. (Cassar-PTT)
W88-09541

PRESSURE INTERFERENCE DATA ANALYSIS FOR TWO-PHASE (WATER/STEAM) GEOTHERMAL RESERVOIRS,
S-Cubed, La Jolla, CA.
S. K. Garg, and J. W. Pritchett.
Water Resources Research WRERAO, Vol. 24, No. 6, p 843-852, June 1988. 10 fig, 3 tab, 10 ref.

Descriptors: *Drawdown, *Groundwater reservoirs, *Geothermal studies, *Steam, *Water pressure, Thermal water, Heated water, Model studies, Mathematical models, Wells, Drawdown, Transmissivity.

A procedure was developed for analyzing pressure interference (drawdown) data from a hot-water geothermal reservoir which evolves into a two-phase system as a result of fluid production. The observation well was assumed to remain in the single-phase (liquid) part of the reservoir. A numerical geothermal reservoir simulator was used in a series of calculations to test the limits of applicability of the interpretation procedure. Results suggested that the accuracy of the computed reservoir transmissivity depends somewhat on the size of the induced two-phase region. With an extensive two-phase zone, the apparent mass flow rate is a small fraction of the actual production rate and the method provides only a good first approximation for the reservoir transmissivity; forward modeling (history matching) with a numerical reservoir simulator can be used to refine this transmissivity estimate. Results also showed that the observation well pressure buildup data obeys the superposition principle after the return of the reservoir to single-phase conditions. (Cassar-PTT)
W88-09542

MEASUREMENT AND SIMULATION OF ONE-DIMENSIONAL TRANSIENT THREE-PHASE FLOW FOR MONOTONIC LIQUID DRAINAGE,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
R. J. Lenhard, J. H. Dane, J. C. Parker, and J. J. Kaluarachchi.
Water Resources Research WRERAO, Vol. 24, No. 6, p 853-863, June 1988. 11 fig, 1 tab, 34 ref.

Descriptors: *Multiphase flow, *Groundwater movement, *Oil fields, *Fluid flow, *Porous media, Sand aquifers, Aquifer characteristics, Water pressure.

Simultaneous movement of oil, water, and air in a sandy porous medium was investigated experimentally under transient flow conditions, and results were compared to numerical simulations employing a fine element multiphase flow code. The liquid hydrocarbon was Soltrol 170, a low-density branched alkane mixture. Liquid saturations were measured using a colinear dual-energy gamma radiation apparatus, and liquid pressures were measured using hydrophilic (untreated) and hydrophobic (treated) ceramic tensiometers connected to pressure transducers. The experimental regime was selected to impose monotonically draining water and total liquid saturation paths to avoid hysteretic effects. Measured saturations and pressures were compared to values obtained from numerical simulations of the experiment using a finite element solution of the governing multiphase flow equations, assuming negligible gas pressure gradients. Functional relationships between permeabilities, saturations (S), and capillary pressures (P) employed in the numerical model were estimated by two calibration methods which require different degrees of experimental effort. Measured transient water saturation versus oil-water capillary head data agreed well with predictions from static air-water S-P relations and interfacial tension data.

Transient total liquid saturation versus air-oil capillary head data deviated more severely from the scaled air-water S-P data, possibly reflecting noncompliance with the assumption of negligible gas pressure gradients. Reasonably good agreement was observed between measured and numerically simulated water and oil saturations and pressures in space and time. Sensitivity of the numerical results to calibration method was not great. (Author's abstract)
W88-09543

GEOCHEMICAL ANALYSIS OF RIYADH GROUND WATER,
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Physics.
For primary bibliographic entry see Field 2K.
W88-09578

MANGANESE IN DRINKING WATER OF THE TOWN OF BEAUCAIRE: ORIGINS AND SOLUTIONS (MANGANESE DANS L'EAU D'ALIMENTATION DE LA VILLE DE BEAUCAIRE: ORIGINES ET SOLUTIONS),
Aix-Marseille-1 Univ. (France). Lab. de Chime Generale.
For primary bibliographic entry see Field 5B.
W88-09597

HYDROCARBONS AND AROMATIC HYDROCARBONS IN GROUNDWATER SURROUNDING AN EARTHEN WASTE DISPOSAL PIT FOR PRODUCED WATER IN THE DUNCAN OIL FIELD OF NEW MEXICO,
New Mexico State Univ., Las Cruces. Dept. of Chemistry
For primary bibliographic entry see Field 5B.
W88-09599

POLYCYCLIC AROMATIC HYDROCARBONS IN SOIL AT GROUNDWATER LEVEL NEAR AN EARTHEN PIT FOR PRODUCED WATER IN THE DUNCAN OIL FIELD,
New Mexico State Univ., Las Cruces. Dept. of Chemistry
For primary bibliographic entry see Field 5B.
W88-09611

DISSOLVED ORGANIC CARBON IN STREAMS AND GROUNDWATER,
Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 2K.
W88-09636

ROLE OF GROUNDWATER IN THE IMPACT OF CLIMATE WARMING ON STREAM SALMONINES,
Toronto Univ. (Ontario). Dept. of Zoology.
J. D. Meisner, J. S. Rosenfeld, and H. A. Regier.
Fisheries, Vol. 13, No. 3, p 2-8, May/June 1988. 4 fig, 1 tab, 56 ref.

Descriptors: *Climates, *Climatology, *Stream biota, *Groundwater, *Water temperature, *Temperature effects, *Salmon, *Fish populations, Solar radiation, Climates, Geothermal studies, Soil temperature, Spawning, Hydrologic maps.

The factors that govern the temperature of groundwater and the influence of groundwater on salmonine ecology are reviewed in an attempt to show the role groundwater will play in the impact of climate warming on stream salmonines. The mechanisms of energy transfer from the atmosphere through groundwater to stream water are complex. Groundwater temperatures are expected to follow projected increases in mean annual air temperature from climate warming, as modified by local microclimatic and topographic conditions for which some general quantitative relationships are given. At a particular site, increased groundwater temperature will increase the temperatures in redds of salmonines and may depress oxygen concentrations, both of which affect survival and growth of developing eggs and larvae. At low altitudes and latitudes, optimal thermal habitats of salmonines will likely shrink in summer. The converse will likely occur in streams at high altitudes and high latitudes. (Author's abstract)
W88-09677

GEOMORPHOLOGICAL CONTROL OF SUBSURFACE HYDROLOGY IN THE CREEK-BANK ZONE OF TIDAL MARSHES,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2L.
W88-09715

MODIFICATION OF TEMPERATURE BEHAVIOUR THROUGH REGULATION OF A BRITISH RIVER SYSTEM,
Exeter Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 4A.
W88-09721

HYDROLOGIC IMPACTS OF IMPROVED IRRIGATION EFFICIENCIES,
Wyoming Univ., Laramie. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W88-09743

APPLYING THE USGS MASS-TRANSPORT MODEL (MOC) TO REMEDIAL ACTIONS BY RECOVERY WELLS,
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
A. I. El-Kadi.
Ground Water GRWAAR, Vol. 26, No. 3, p 281-288, May-June 1988. 12 fig, 2 tab, 18 ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Recharge wells, *Groundwater movement, *Model studies, *Recovery wells, *Injection wells, *Mass transport model, Hydrodynamics, Algorithms, Errors, Plumes, Wells, Mathematical models, Flow, Simulation analysis, Computer programs.

The USGS two-dimensional mass-transport model (MOC) is widely used in the analysis of groundwater contamination problems. A need exists to examine the accuracy of the code in situations dominated by radially convergent and divergent flow around wells. The model is applied here to situations that commonly exist in remedial actions involving recovery wells. The cases simulated are a recharge/recovery single well, a recharge/recovery doublet, and plume capture by one or two production wells. The results were tested against analytical and semianalytical solutions. Inaccuracies in model results occurred especially for the doublet case under controlled long-time simulation. Inaccuracies are caused not only by the mainly radial-flow situation, or by the curvature nature of streamlines, but also by the arrival of contamination at the sink nodes. Better agreement of numerical and analytical solutions was obtained for the single-well and plume-capture situations. However, a large mass-balance error exists for the single-well case. Inaccuracies can be reduced by modifying the code and reducing the finite-difference mesh. However, the use of a very fine mesh (i.e. on the order of a few feet) may prevent the use of the code in large-scale problems. Care must be taken in applying the model to situations where production or injection wells are close to each other. (Author's abstract)
W88-09781

OPTIMIZATION MODEL FOR ANALYSIS OF TEST PUMPING DATA,
Roorkee Univ. (India). School of Hydrology.
D. Kashyap, P. Dachadesh, and L. S. J. Sinha.
Ground Water GRWAAR, Vol. 26, No. 3, p 289-297, May-June 1988. 4 fig, 6 tab, 17 ref.

Descriptors: *Aquifers, *Geohydrology, *Pumping tests, *Model studies, Mathematical models, Computer models, Optimization, Drawdown, Leakage, Anisotropy, Theis equation, Leakage.

An optimization model for computer-assisted estimation of aquifer parameters was developed. It is based on the principle of minimization of the sum of squares of the differences between observed and computed drawdowns. The objective strategy eliminates the subjectivity associated with the conventional curve-matching procedures. Apart from the parameters estimation, the model can assist in identifying certain hydrogeological features like leakage, discontinuities, vertical anisotropy, etc. It also can provide a check on consistency among different data sets monitored during test pumping (e.g., drawdown and recovery data). The application of the proposed model has been illustrated by analysis of field data. The model-computed parameters honored the observed data more closely than the graphical estimates. The model could also identify leakage as the cause of departure of the time-drawdown curve from the Theis type of curve. In another study, the model results lead to an inference that the recovery data of the pumped well are consistent with the rest of the data. (Author's abstract)
W88-09782

FINITE-ELEMENT SIMULATION OF LONG-TERM TRANSIENT REGIONAL GROUNDWATER FLOW,
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
L. A. England, and R. A. Freeze.
Ground Water GRWAAR, Vol. 26, No. 3, p 298-308, May-June 1988. 6 fig, 3 tab, 16 ref.

Descriptors: *Groundwater movement, *Flow equations, *Model studies, *Finite element method, Hydraulic conductivity, Hydrodynamics, Mathematical models, Simulation analysis, Topography, Stratigraphy, Erosion, Plumes, Alberta, Canada.

A finite-element model is developed to solve the two-dimensional, transient, groundwater flow equation on a regional scale over geologic time for the purpose of assessing the rate of hydraulic head decay at depth in response to erosional modifications of the land surface. The model includes a time-stepping procedure that allows consideration of sedimentary basins with large hydraulic conductivity contrasts. Results confirm that hydraulic head patterns that are not in equilibrium with existing topography can persist at depth over geologically significant periods of time. A sensitivity analysis on a hypothetical layered system shows that the rate of hydraulic head adjustment, due to erosional modifications of the topography, is particularly sensitive to the thickness, continuity, and vertical hydraulic conductivity of the low-permeability layers. Application of the two-dimensional model to the Red Earth region of northern Alberta, Canada predicts response times that are reduced by two-thirds over those predicted with one-dimensional models. The concept of delayed hydraulic response over geological time has important implications in the siting and design of nuclear waste repositories, the analysis of contaminant plume migration, and the use of the hydrodynamic approach to the exploration for petroleum resources and stratabound ore deposits. (Author's abstract)
W88-09783

VICTORIA PROVINCE DROUGHT RELIEF PROJECT: I. GEOPHYSICAL SITING OF BOREHOLES,
Hydrotechnica, Shrewsbury (England).
C. C. White, J. F. T. Houston, and R. D. Barker.
Ground Water GRWAAR, Vol. 26, No. 3, p 309-316, May-June 1988. 11 fig, 1 tab, 15 ref.

Descriptors: *Boreholes, *Water supply development, *Geohydrology, *Aquifer characteristics, Borehole geophysics, Regoliths, Mineralogy, Victoria Province, Resistivity, Drought, Zimbabwe.

As a result of the recent drought in central Africa, an accelerated well drilling program was commissioned in Victoria Province, Zimbabwe, to help alleviate the water shortage. An analysis of the data collected during the siting of these boreholes showed that geophysical techniques can be used reliably to determine regolith thickness and provide an indication of regolith lithology. Valleys

and the zone of deep weathering around bornhardts were found to have the greatest potential for water-supply boreholes. The relationship between regolith resistivity and specific capacity is masked by the clay mineralogy of the regolith which must be taken into account when siting boreholes. Despite this effect, optimum values of regolith resistivity for production boreholes in Victoria Province were established which may be of value in similar Basement terrain elsewhere. (Author's abstract)
W88-09784

HYDROCHEMICAL CHARACTERIZATION OF BRINES AND IDENTIFICATION OF BRINE CONTAMINATION IN AQUIFERS,
Kent State Univ., OH. Dept. of Geology.
For primary bibliographic entry see Field 5A.
W88-09785

INFLUENCE OF OUTLYING OBSERVATIONS ON SELECTED ESTIMATES OF PARAMETERS OF DISTRIBUTIONS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 7C.
W88-09786

ARSENIC IN GROUND WATER OF THE WESTERN UNITED STATES,
Geological Survey, Carson City, NV.
For primary bibliographic entry see Field 2K.
W88-09787

COLLECTION MANIFOLD FOR MULTILEVEL GROUND-WATER SAMPLING DEVICES,
British Geological Survey, Keyworth (England). Fluid Processes Research Group.
For primary bibliographic entry see Field 7B.
W88-09788

EXERCISE IN GROUND-WATER MODEL CALIBRATION AND PREDICTION,
Stanford Univ., CA. Dept. of Civil Engineering.
D. L. Freyberg.
Ground Water GRWAAR, Vol. 26, No. 3, p 350-360, May-June 1988. 12 fig, 5 tab, 14 ref. National Science Foundation Grant ECE-8451565.

Descriptors: *Groundwater movement, *Model studies, *Geohydrology, Aquifer characteristics, Hydraulic conductivity, Hydrodynamics, Prediction, Boundary conditions, Simulation analysis, Performance evaluation, Education.

For a classroom exercise, 9 groups of graduate students calibrated a numerical groundwater flow model to a set of perfectly observed hydraulic head data for a hypothetical phreatic aquifer. All groups used exactly the same numerical model and identical sets of observed data. After calibration, the students predicted the hydraulic head distribution in the aquifer resulting from a modification in one boundary condition. A quantitative analysis of the results of this calibration-prediction exercise vividly demonstrates some of the difficulties in parameter identification for groundwater flow models. Group predictions differed significantly. Successful prediction was strongly correlated with successful estimation of conductivity values, and was essentially unrelated to successful estimation of aquifer bottom elevations or with the number of trial-and-error simulations required for calibration. Most importantly, success in prediction was unrelated to success in matching observed heads under premodification conditions. In this sense, good calibration did not lead to good prediction. (Author's abstract)
W88-09789

MICROBIAL COMMUNITIES IN THE SATURATED GROUNDWATER ENVIRONMENT: I. METHODS OF ISOLATION AND CHARACTERIZATION OF HETEROTROPHIC BACTERIA,
Bremen Univ. (Germany, F.R.).
For primary bibliographic entry see Field 7B.
W88-09791

MICROBIAL COMMUNITIES IN THE SATURATED GROUNDWATER ENVIRONMENT: II. DIVERSITY OF BACTERIAL COMMUNITIES IN A PLEISTOCENE SAND AQUIFER AND THEIR IN VITRO ACTIVITIES,
Bremen Univ. (Germany, F.R.).
J. Kolbel-Boelke, E.-M. Anders, and A. Nehrkorn.
Microbial Ecology MCBEBU, Vol. 16, No. 1, p 31-48, 1988.

Descriptors: *Soil bacteria, *Classification, *Aquifer characteristics, *Bacteria, *Groundwater, *Sand aquifers, West Germany, Sediments, Bacterial physiology, Morphology, Physiological ecology.

Bacterial cell numbers obtained from 103 water and sediment samples from a Pleistocene sandy aquifer in the Lower Rhine region were determined on P-agar and by direct count. Below 5 m under the surface, colony-forming unit numbers in water samples were <100/ml, and in many cases <50/ml. In sediment samples, they were 10- to 100-fold higher, but changing markedly between different depths. Direct cell counts yielded numbers 2-3 orders of magnitude higher. About 2,700 strains from 60 samples were isolated randomly and characterized by morphological and physiological properties. Of all the isolates, 71.6% were gram-negative, and 52.2% were gram-negative straight rods. Water communities had low proportions of gram-positive bacteria ($<11\%$), whereas in all but one of the sediment communities percentages of gram-positive isolates were 3- to 7-fold higher (35-43%). Water and sediment communities, as well as communities from different sampling sites and from different depths of the same sampling site, differed in their qualitative and quantitative morphotype composition and physiological capabilities. The in vitro activities of strains within a single community were quite different, indicating that each community is composed of many diverse bacteria. Gram-positive bacteria showed on an average lower total activities and gram-negative bacteria. Both gram-positive and -negative bacteria from sediment had higher values of in vitro activities than the corresponding groups isolated from water. Many water and sediment bacteria preferred the same substrates which were utilized at higher rates. However, there were differences in the degradation of the various other substrates present, and each community showed preferences for particular substrates. Results of cell morphology and physiology studies indicated that all 8 characterized communities were very different from one another and very diversely structured. (See also W88-09791) (Author's abstract)
W88-09792

MORPHOLOGICAL AND CULTURAL COMPARISON OF MICROORGANISMS IN SURFACE SOIL AND SUBSURFACE SEDIMENTS AT A PRISTINE STUDY SITE IN OKLAHOMA,
Florida State Univ., Tallahassee. Dept. of Biological Science.
T. L. Bone, and D. L. Balkwill.
Microbial Ecology MCBEBU, Vol. 16, No. 1, p 49-64, 1988. 4 fig, 6 tab, 22 ref. Environmental Protection Agency Cooperative Agreement CR811148.

Descriptors: *Soil, *Subsurface sediments, *Aquifers, *Microorganisms, *Soil bacteria, *Soil fungi, Oklahoma, Bacterial physiology, Vertical distribution, Morphology, Lula.

Surface-soil and subsurface microfloras at the site of a shallow aquifer in Oklahoma were examined and compared with respect to (1) total and viable cell numbers, (2) colony and cell types that grew on various plating media, (3) cell morphologies seen in flotation films stripped from sample particles, and (4) cellular ultrastructure. Appreciable numbers of microbial cells were present in the subsurface (total counts: 1-10 million cells/g; viable counts up to 1 million cells/g), but the subsurface microflora was considerably less populous than that of the surface soil (total counts: 1 billion cells/g; viable counts 10-100 million cells/g). The subsurface microflora (especially that of the saturated zone) also appeared to be much less diverse, containing fewer microbial types that would grow on enumeration plates (on nutrient-rich media, 3-4 colony types vs. 19-22 for the surface soil) and fewer cell types that could be distinguished by direct microscopy (3-4 types vs. 17 for the surface soil). The specific types of microorganisms that were numerically predominant in the aquifer sediments were entirely different from those that were predominant in the surface soil. Moreover, the predominant types varied from one depth to another within the saturated zone. The potential metabolic capability of the subsurface microflora, as indicated by its readiness to grow rapidly on nutrient-rich media, also varied with depth. (See also W88-09796) (Author's abstract)
W88-09793

INVESTIGATIONS INTO THE NUMBER OF RESPIRING BACTERIA IN GROUNDWATER FROM SANDY AND GRAVELLY DEPOSITS,
Max-Planck-Inst. fuer Limnologie, Schlitz (Germany, F.R.). Limnologische Flussstation.
For primary bibliographic entry see Field 5B.
W88-09794

EQUIVALENCE OF MICROBIAL BIOMASS MEASURES BASED ON MEMBRANE LIPIDS AND CELL WALL COMPONENTS, ADENOSINE TRIPHOSPHATE, AND DIRECT COUNTS IN SUBSURFACE AQUIFER SEDIMENTS,
Florida State Univ., Tallahassee. Dept. of Biological Science.
For primary bibliographic entry see Field 7B.
W88-09795

DISTRIBUTION AND ACTIVITY OF MICROORGANISMS IN SUBSURFACE SEDIMENTS OF A PRISTINE STUDY SITE IN OKLAHOMA,
Cornell Univ., Ithaca, NY. Dept. of Microbiology.
R. M. Beloin, J. L. Sinclair, and W. C. Ghiorse.
Microbial Ecology MCBEBU, Vol. 16, No. 1, p 85-97, 1988. 4 fig, 1 tab, 28 ref. Environmental Protection Agency Cooperative Agreement No. CR 811148.

Descriptors: *Aquifers, *Subsurface sediments, *Microorganisms, *Soil bacteria, *Protozoa, *Cyanobacteria, *Cyanophyta, Biomass, Adenosine triphosphate, Seasonal variation, Vertical distribution, Saturated zone, Aeration zone, Soil types, Sand, Clays, Oklahoma.

Distribution and activity of microorganisms in surface soil and subsurface sediments were studied in depth profiles of 6 different microbial biomass and activity indicators (total direct counts, number of cells capable of electron transport system activity, viable cell plate counts, most probable numbers of protozoa, and 4-hydroxybenzoate-degrading microorganisms, and ATP content). The profiles showed the same general trends on two different dates (January amd June). Seasonal variations were noted, but they were not extreme. Biomass and activity values declined sharply with depth in the unsaturated zone, reaching minima in a clay confining layer in the interface zone between 3 and 4 m. Contiguous 10-cm samples from the interface zone showed significant textural and microbiological variability. Higher and more stable biomass and activity values were detected in the saturated zone, the highest being a very permeable gravelly loamy sand layer at approximately 7.5 m. In this layer, viable counts were nearly equal to total counts and they approached the viable counts in surface soil. Surface-type protozoa and cyanobacteria also were detected in this layer, suggesting that it was connected hydrologically to a nearby river. Lowest values were detected in an underlying bedrock clay layer at 8 m, which, despite its impermeability and low viable counts, did contain measurable total counts, 4-hydroxybenzoate-degrading microorganisms, and ATP. Correlations were noted between sediment texture and microbial activity (i.e., sandy texture = high activity, clayey texture = low activity), but other hydrogeological and geochemical factors probably also influenced microbial dis-

tribution and activity in the profile. (See also W88-09793) (Author's abstract)
W88-09796

SOME SPECIAL PROBLEMS IN THE DETERMINATION OF VIABLE COUNTS OF GROUNDWATER MICROORGANISMS,
Kiel Univ. (Germany, F.R.). Inst. fuer Allgemeine Mikrobiologie.
For primary bibliographic entry see Field 7B.
W88-09797

CHEMICAL COMPOSITIONS OF SUBMARINE HOT SPRING WATER AND ASSOCIATED BOTTOM SEDIMENTS NEAR TAKETOMI-JIMA AT SOUTHERN PART OF THE RYUKYU ISLAND ARC, NORTH-WEST PACIFIC,
University of the Ryukyus, Nishihara (Japan). Dept. of Chemistry.
For primary bibliographic entry see Field 2K.
W88-09799

CHEMICAL STUDY OF SURFACE AND GROUND WATERS FLOWING THROUGH CARBONATE ROCK TERRAIN IN THE OKINAWA ISLANDS,
University of the Ryukyus, Nishihara (Japan). Dept. of Chemistry.
A. Tokuyama.
Journal of Earth Science Nagoya University JEASAD, Vol. 35, No. 2, p 399-416, December 1987. 20 fig, 3 tab, 20 ref.

Descriptors: *Groundwater, *Weathering, *Geochemistry, *Water Chemistry, *Surface water, *Carbonate rocks, *Chemical composition, Limestone, Calcium, Bicarbonate, Magnesium, Potassium, Calcite, Dolomite, Protodolomite, Okinawa Islands, Chemical reactions.

In Okinawa, limestone is widely distributed on many islands and protodolomite on Kita and Minami Daito islands. Waters from these terrains were chemically studied and the following results were obtained. Total amounts of dissolved chemical species and excess amounts of dissolved chemical species with respect to sea water composition are larger in water samples from protodolomite terrains than in those from limestone terrains. In limestone terrains, some water samples were contained larger concentration of Ca than HCO3 in equivalent units. SO4 and NO3 ions may be considered to balance Ca ions in these waters. On the other hand, some water samples contained more HCO3 than Ca in equivalent units. In this case, Mg dissolution from mudstones seems to be significant. Waters containing high excess amount of K seem to be influenced by human activities. Many water samples from limestone terrains were supersaturated with respect to calcite but undersaturated with respect to dolomite, whereas the reverse observations were obtained in water samples from protodolomite terrains. High biological activity supplies a large amount of CO2 to sedimentary environments in Okinawa areas. It causes the acceleration of carbonate rock dissolution. The amount of organic materials which are decomposed to supply CO2 was estimated. Because of the small size of islands with a large fluctuation of environmental state, physical and chemical processes for the weathering of rocks may give a significant influence on the nature of Okinawa. In addition to the natural weathering process, human activities may accelerate the modification of the environment of Okinawa. (Author's abstract)
W88-09803

GEOCHEMICAL STUDY OF WEATHERING THROUGH CHEMICAL COMPOSITION IN NATURAL WATERS,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 2K.
W88-09804

CONCEPTS OF WELL CLEANING,
Bennett, Williams and Blattert, Inc., Indianapolis, IN.
For primary bibliographic entry see Field 3B.
W88-09832

ADVANCED OXIDATION PROCESSES FOR TREATING GROUNDWATER CONTAMINATED WITH TCE AND PCE: LABORATORY STUDIES,
California Univ., Los Angeles. School of Public Health.
For primary bibliographic entry see Field 5F.
W88-09834

ADVANCED OXIDATION PROCESSES FOR TREATING GROUNDWATER CONTAMINATED WITH TCE AND PCE: PILOT-SCALE EVALUATIONS,
Montgomery (James M.), Inc., Pasadena, CA.
For primary bibliographic entry see Field 5F.
W88-09835

INTERSTITIAL FAUNAL COMMUNITIES OF THE HYPORHEIC AND ADJACENT GROUNDWATER BIOTOPES OF A COLORADO MOUNTAIN STREAM,
Colorado Univ. at Boulder.
For primary bibliographic entry see Field 2H.
W88-09879

ALGAE IN GROUND WATERS BELOW THE ACTIVE STREAM OF A RIVER (BASIN OF THE MORAVA RIVER, CZECHOSLOVAKIA),
Ceskoslovenska Akademie Ved, Trebon. Dept. of Hydrobotany.
For primary bibliographic entry see Field 2H.
W88-09894

INTERPRETING INJECTION WELL TESTS IN AN ALLUVIAL AQUIFER,
Birmingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W88-09914

ESTIMATING AQUIFER RECHARGE AND PARAMETERS FROM WATER LEVEL OBSERVATIONS,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
A. Das Gupta, and G. N. Paudyal.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 103-116, May 1988. 9 fig, 2 tab, 15 ref.

Descriptors: *Recharge, *Groundwater level, *Infiltration, *Rainfall, *Groundwater recharge, *Aquifers, *Model studies, Climatology, Weather data collections, Evapotranspiration, Field tests, Performance evaluation, Equations.

This paper is concerned with the development of a technique to estimate recharge from rainfall, and to estimate aquifer parameters, using groundwater level records and available climatological data. The methodology combines a hydrometeorological model which links rainfall and evapotranspiration to the effective groundwater recharge, and a geohydrologic model which links the recharge to the water level in the aquifer. Results of field application are presented to illustrate the usefulness of the technique. (Author's abstract)
W88-09918

PALEOHYDROLOGY OF THE NUBIAN AQUIFER NORTHEAST OF THE BLUE NILE, NEAR KHARTOUM, SUDAN,
Directorate General of Water Supply and Transport, Salalah (Oman).
Y. A. S. Haggaz, and K. M. Kheirallah.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 117-125, May 1988. 5 fig, 5 ref.

Descriptors: *Paleohydrology, *Nubian aquifer, *Surface-groundwater relations, *Geohydrology, *Tracers, *Geochemistry, Aquifers, Isotope studies, Chemical analysis, Water chemistry, Groundwater recharge, Spatial distribution, Regional analysis, Rainfall, Ions, Sudan, Nile River.

Environmental isotopes and ionic water chemistry have been used to study the aspects of recharge to the Nubian aquifer near the confluence of the Blue and White Niles. The results indicated that recharge to the phreatic Nubian aquifer occurs mainly through bed transmission losses of the Blue Nile during flood times and is limited to a zone 13 km east of the river. The groundwater in this zone and the Blue Nile water are relatively enriched in the stable heavy isotopes and are both characterized by a sodium bicarbonate water type low in sulfate and chloride. Beyond this zone the groundwater is much depleted in heavy isotopes and contains more than 2000 ppm of total dissolved solids, and is dominated by a calcium/sodium bicarbonate water type rich in chloride. Away from the Blue Nile values of heavy isotopes in the Nubian aquifer are quite different from those of modern rainfall of the region and correlate fairly well with values of a colder climatic zone. Hence it is postulated that the regional gradient of the Nubian aquifer is a decaying fossil gradient of a pluvial period in the Pleistocene. (Author's abstract)
W88-09919

SINGLE-WELL TRACER TECHNIQUE FOR EVALUATING AQUIFER PARAMETERS: I. THEORETICAL WORK,
Hydrology Service, Jerusalem (Israel).
For primary bibliographic entry see Field 7B.
W88-09921

TOWARDS A DELIMITATION OF SOUTH-WESTERN NIGERIA INTO HYDROLOGICAL REGIONS,
Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W88-09922

QUANTITATIVE TRACING OF THE MALIGNE KARST SYSTEM, ALBERTA, CANADA,
University of Western Ontario, London. Dept. of Geography.
C. C. Smart.
Journal of Hydrology JHYDA7, Vol. 98, No. 3/4, p 185-204, April 15, 1988. 7 fig, 4 tab, 22 ref.

Descriptors: *Karst, Karst Hydrology, *Aquifer characteristics, *Groundwater movement, *Conduits, *Tracers, *Fluorometry, Canada, Sinks, Groundwater, Quantitative analysis, Alberta, Field tests, Lakes, Conduits, Sinking lakes.

Early dye tracing studies on the large Maligne karst aquifer in the Canadian Rocky Mountains gave indeterminate results and low tracer recoveries. In contrast, a recent series of tests using high-precision field fluorometry gave well defined breakthrough curves and far higher but variable recovery. Low recovery in one test may be accounted for by hydraulic switching or interaction with an alluvial aquifer which buries the principal conduit outlets. A 16-km long karst conduit averaging between 90 and 170 sq m in cross-sectional area drains the principal sinking lake to a group of karst springs. A 14-km tributary conduit, linking a high karst valley to the major conduit, both drains and feed the karst lake, although during winter it has flows transitional between laminar and turbulent regimes. A strong non-linear relation between travel time and discharge suggests a partly vadose system that is little influenced by unsteady flow. Static and maximum dynamic conduit storage were estimated to be 1,950,000 and 760,000 cu m, respectively. (Author's abstract)
W88-09973

BEHAVIOR OF GROUNDWATER WITH DISPERSION IN COASTAL AQUIFERS,
Ehime Univ., Matsuyama (Japan). Dept. of Ocean Engineering.
T. Kakinuma, Y. Kishi, and K. Inouchi.
Journal of Hydrology JHYDA7, Vol. 98, No. 3/4, p 225-248, April 15, 1988. 15 fig, 25 ref.

Descriptors: *Groundwater movement, *Estuaries, *Coastal aquifers, *Estuaries, *Saline water intrusion, *Model studies, Confined aquifers, Mathematical models, Piezometric surface, Hydraulic models, Simulation, Japan, Groundwater, Dispersion.

A 3-dimensional steady-state hydrodynamic model is used to simulate seawater encroachment in the confined aquifers in the estuaries of the Naka and Kiki Rivers in Japan. Two expressions of the dispersion coefficient are considered; one is constant over the entire region of the aquifer and the other is dependent on the flow velocity of the groundwater. The magnitudes of the constant dispersion coefficients in the horizontal and vertical directions, D sub xx and D sub zz, as well as the longitudinal and lateral dispersivities, a sub L and a sub T, are determined to reproduce the regional distributions of salt concentration in the confined aquifers in both estuaries. It is found that D sub xx equals 5 sq cm per second, D sub zz equals 5-0.5 sq cm per second, and a sub L equals 1000-1250 m, a sub T equals 200-20 m in the Naka River estuary; and D sub xx equals 0.2 sq cm per second, D sub zz equals 0.2-0.02 sq cm per second, and a sub L equals 200 m, a sub T equals 200-20 m in the Kiki River estuary. Examining the local distribution of the dispersion coefficient computed from the dispersivity and velocity fields of groundwater in both estuaries, the same value as estimated in the analysis with constant dispersion is located in the middle layer of the aquifer. In the estuary of the Naka River, the piezometric surface predicted with the dispersion model with the velocity-dependent dispersion coefficient is almost the same as that predicted with the dispersion model with the constant dispersion coefficient and they are 5-10% lower than that predicted with the interface model. They are, however, about 1.3 times the observed piezometric surface. (Author's abstract)
W88-09975

EXPERIMENTAL STUDIES IN STREAM-AQUIFER INTERACTION ALONG THE ARKANSAS RIVER IN CENTRAL KANSAS: FIELD TESTING AND ANALYSIS,
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 4B.
W88-09976

NITRATE RETENTION AS IT AFFECTS GROUNDWATER POLLUTION IN MID-ATLANTIC SOILS,
Delaware Univ., Newark. Dept. of Plant Science.
For primary bibliographic entry see Field 5B.
W88-10006

ANALYSIS OF HISTORICAL AND CURRENT DRAWDOWN AND PRODUCTION DATA FROM THE BOISE GEOTHERMAL SYSTEM,
Boise State Univ., ID. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 4B.
W88-10011

GEOCHEMICAL ASSESSMENT OF AQUIFER RECHARGE EFFECTS IN THE SOUTHWEST DENVER BASIN,
Colorado School of Mines, Golden. Dept. of Geology.
For primary bibliographic entry see Field 4B.
W88-10028

LARGE SCALE PARAMETER ESTIMATION THROUGH THE INVERSE PROCEDURE AND UNCERTAINTY PROPAGATION IN THE COLUMBUS BASIN, NEW MEXICO,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
For primary bibliographic entry see Field 4B.
W88-10042

JANUARY 1987 WATER LEVELS, AND DATA RELATED TO WATER-LEVEL CHANGES, WESTERN AND SOUTH-CENTRAL KANSAS,
Geological Survey, Lawrence, KS. Water Resources Div.
B. J. Dague.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Open-File Report 87-241, 1987. 161 p, 2 fig, 1 tab, 18 ref.

Descriptors: *Groundwater, *Kansas, *Hydrologic data, Water-level changes, Data collections.

Hydrologic data related to water-level measurements were collected in observation wells in western and south-central Kansas. The measurements were made in midwinter when pumping was minimal and water levels had recovered, for the most part, from the effects of pumping during the previous irrigation season. Annual hydrologic data are provided for relating water-level changes from a 'base-reference year' (predevelopment year), a year of abnormally large amounts of precipitation and minimum pumpage (1966 or 1974), and each of 7 consecutive years of measurements (1980-86). The 'base-reference year' is designated as 1940 for the southwestern area, 1944 for the south-central area, and 1950 for the northwestern, west-central, and Equus beds areas. Data also are provided for relating the average annual water-level changes, saturated thicknesses of the water-bearing deposits, and percentage changes in saturated thickness. (USGS)
W88-10046

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER, WEST-CENTRAL FLORIDA, MAY 1987,
Geological Survey, Tampa, FL. Water Resources Div.
B. R. Lewelling.
Available from the OFSS, USGS, Box 25425 Lakewood, Co 80225. USGS Open-File Report 87-451, 1 plate (map).

Descriptors: *Maps, *Potentiometric level, *Florida, Groundwater movement, Hydrology, Hydrogeology, Geohydrology.

A May 1987 potentiometric surface map of the Upper Floridan aquifer in west-central Florida depicts water levels for the annual low water-level period. Water levels in most wells measured in May 1987 were lower than in September 1986. May levels averaged about 0.5 foot higher than September levels in latitudes north of the Hillsborough-Pasco County line and about 6 feet lower in southern areas. The average water-level change between May 1986 and May 1987 in individual wells was more than 3 feet. Average water levels in most wells measured in May 1987 were more than 2 feet higher than May 1986 levels in the north and more than 4 feet higher in the south. (USGS)
W88-10047

HYDROLOGY OF AREA 53, NORTHERN GREAT PLAINS AND ROCKY MOUNTAINS COAL PROVINCES, COLORADO, WYOMING, AND UTAH,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W88-10055

GEOHYDROLOGIC AND SURFACE-WATER DATA FOR THE SACO RIVER VALLEY GLACIAL AQUIFER FROM BARTLETT, NEW HAMPSHIRE TO FRYEBURG, MAINE: OCTOBER 1983 THROUGH JANUARY 1986,
Geological Survey, Augusta, ME. Water Resources Div.
C. D. Johnson, D. H. Tepper, and D. J. Morrissey.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Open-File Report 87-44, 1987. 80 p, 5 fig, 23 tab, 16 ref.

Descriptors: *Areal hydrogeology, *Glacial aquifers, *Water quality, *Groundwater levels, *Hydrologic data, *Maine, *New Hampshire, Stratigraphy, Surface water, Data collections, Oxford County, Carroll County, Groundwater.

Hydrogeologic data was collected for a study of the Saco River valley glacial aquifer. The study area extends along the Saco River from Bartlett, New Hampshire to Fryeburg, Maine. The study was done in cooperation with the Maine Geological Survey (Department of Conservation), the New Hampshire Water Supply and Pollution Control Commission, the New Hampshire Water Resources Board, and the Town of Conway, New Hampshire. The data include information on 54 well-inventory sites, 69 exploration-hole logs, analyses of grain-size distribution in 130 samples of glacial sediments, monthly water-table measurements in 100 wells, and continuous water-table measurements in 7 wells. Discharge data are presented from 6 stream-gaging stations operated for this study during the 1984 and 1985 water years. Data from 50 sets of seepage runs and 15 miscellaneous discharge measurements conducted on the mainstream of the Saco River and on 7 tributary streams during the 1984 and 1985 water years are also presented. Water quality analyses of groundwater samples from 92 sites and surface water samples from 12 sites are presented. Field determinations include pH, temperature, and specific conductance. Laboratory determinations include nutrients, common inorganic anions and cations, selected volatile organic compounds, and detergents. Maps show the locations of data-collection sites. (USGS)
W88-10056

SELECTED WATER-QUALITY DATA FOR THE MINIDOKA IRRIGATION DISTRICT, SOUTH-CENTRAL IDAHO, JUNE 1987,
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W88-10057

DIGITAL-MODEL SIMULATION OF THE AQUIFER SYSTEM I THE TOPPENISH CREEK BASIN, YAKIMA INDIAN RESERVATION, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
J. A. Skrivan.
Available from the OFSS, USGS, Box 25425 Lakewood, CO 80225. USGS Water-Resources Investigations Report 82-4010, 1987. 47 p, 23 fig, 5 tab, 25 ref.

Descriptors: *Water resources appraisals, *Aquifer characteristics, *Mathematical models, *Groundwater movement, *Washington, Model studies, Yakima Indian Reservation.

A groundwater flow model was constructed for the Toppenish Creek basin aquifer system in eastern Washington. Flow was simulated in three aquifer units: (1) the confined old valley fill and shallow basalt (unit 2); (2) the underlying primary basalt (unit 3); and (3) the deep basalt (unit 4). Water levels in the overlying unconfined alluvial aquifer (unit 1) were held fixed. Calibrated transmissivities ranged from 0.01 to 0.48 foot squared per second. Calibrated storage coefficients were 0.0004 to 0.006. The confining-bed leakance ranged from 2.0 x 10 to the minus 11th power to 2.5 x 10 to the minus 10th power feet per second per foot. Under steady-state conditions (1954) annual natural recharge was about 29,000 acre-ft underflow from adjacent basins. Annual pumpage increased from less than 500 acre-ft in 1954 to an average of 19,600 acre-ft for 1971 and 1972. Pumpage caused simulated declines in unit 3 of up to 95 ft for 1955-72. Projected annual declines from 1973-77 using 1971-72 pumpage were about 0.5-1.5 ft in unit 2 and 0.2-1 ft in unit 3. The corresponding declines from 1978-82 were 0.2-1.2 ft and 0.2-0.8 ft, respectively. Using 1971-72 pumpage plus 12,400 acre-ft per year from unit 3, the calculated annual declines from 1978-82 were 1-36 ft in unit 2 and 4-20 ft in unit 3. (USGS)
W88-10058

GEOLOGY AND WATER RESOURCES OF CLARK COUNTY, SOUTH DAKOTA, PART II: WATER RESOURCES,
Geological Survey, Huron, SD. Water Resources Div.

L. J. Hamilton.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. South Dakota Geological Survey Bulletin 29, 1986. 62 p, 32 fig, 4 tab, 15 ref.

Descriptors: *Groundwater, *Aquifers, *Water supply, *Geohydrology, *South Dakota, Aquifer characteristics, Water quality, Clark County.

Glaciers have deposited up to 600 feet of glacial till and outwash in Clark County on the west side of the 400-foot high Coteau des Prairies in northeastern South Dakota. Outwash sand and gravel 20 to 30 feet thick includes six major glacial aquifers that underlie 70 percent of the county. The Prairie Coteau aquifers are at depths of from a few feet to 300 feet. Beneath these are the Altamont aquifers, at depths of nearly 600 feet beneath the Coteau des Prairies. The Altamont aquifers extend westward into the James basin where they are as shallow as 10 feet. The glacial aquifers can yield as much as 2,000 gallons per minute of slightly-saline very hard water to individual wells. A major bedrock aquifer, the Dakota Formation, is at depths of 900 to 1,400 feet. This aquifer can yield as much as 50 gallons per minute of soft, slightly-saline water. (USGS)
W88-10061

SELECTED DRILL-STEM TEST DATA FOR THE UPPER COLORADO RIVER BASIN,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7B.
W88-10068

COMPUTER SIMULATION OF ALDICARB MIGRATION AND DEGRADATION IN THE SAND PLAIN OF CENTRAL WISCONSIN,
Wisconsin Univ.-Madison. Environmental Toxicology Center.
For primary bibliographic entry see Field 5B.
W88-10082

2G. Water In Soils

PROCESSES AND FACTORS AFFECTING TRANSPORT OF PESTICIDES TO GROUND WATER,
Washington State Univ., Pullman. Dept. of Agronomy and Soils.
For primary bibliographic entry see Field 5B.
W88-09090

SOIL CHARACTERISTICS AFFECTING PESTICIDE MOVEMENT INTO GROUND WATER,
Agricultural Research Service, Beltsville, MD.
For primary bibliographic entry see Field 5B.
W88-09091

QUANTIFYING PESTICIDE ADSORPTION AND DEGRADATION DURING TRANSPORT THROUGH SOIL TO GROUND WATER,
Cornell Univ., Ithaca, NY. Coll. of Human Ecology.
For primary bibliographic entry see Field 5B.
W88-09093

GEOHYDROLOGY OF A FIELD SITE: STUDY OF PESTICIDE MIGRATION IN THE UNSATURATED AND SATURATED ZONES OF DOUGHERTY PLAIN, SOUTHWEST GEORGIA,
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-09094

SPATIAL VARIABILITY OF PESTICIDE SORPTION AND DEGRADATION PARAMETERS,
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W88-09095

1,2-DIBROMOETHANE (EDB) IN TWO SOIL PROFILES,
California Dept. of Food and Agriculture, Sacramento.
For primary bibliographic entry see Field 5B.
W88-09103

MODELING PESTICIDE MOVEMENT IN THE UNSATURATED ZONE OF HAWAIIAN SOILS UNDER AGRICULTURAL USE,
Hawaii Univ., Honolulu. Dept. of Agronomy and Soil Sciences.
For primary bibliographic entry see Field 5B.
W88-09108

METHOD FOR CHARACTERIZING VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN SHALLOW SOILS,
Kennedy/Jenks/Chilton, Irvine, CA.
For primary bibliographic entry see Field 5A.
W88-09325

INSTRUMENTATION OF PORE PRESSURE AND SOIL WATER SUCTION,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 7B.
W88-09337

SLOPE STABILITY ANALYSIS INCORPORATING THE EFFECT OF SOIL SUCTION,
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W88-09338

MODELLING THE EFFECTIVENESS OF A SOIL-CEMENT PROTECTIVE COVER FOR SLOPES,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 8D.
W88-09341

MODELLING INTERRELATIONSHIPS BETWEEN CLIMATE, HYDROLOGY, AND HYDROGEOLOGY AND THE DEVELOPMENT OF SLOPES,
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
For primary bibliographic entry see Field 8D.
W88-09346

'PHYSICS' OF SOIL WATER PHYSICS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
G. Sposito.
IN: The History of Geophysics. American Geophysical Union, Washington DC. 1987. p 93-98, 39 ref. NSF Grant CEE-79-20778.

Descriptors: *Geophysics, *Soil water, History, Physical properties, Buckingham law, Richards equation, Research priorities, Capillarity, Soil water potential, Hydraulic conductivity, Energy, Mathematical studies.

Soil water physics began as a subdiscipline of physics about 1905 when Buckingham published his study on the equilibrium and flow behavior of soil water. He defined capillary potential at a given water content, temperature, and bulk density of soil, to be the reversible work per unit mass required to transfer water from soil to a pure water reservoir. Richards in 1931 measured hydraulic conductivity with a simple apparatus, thus verifying Buckingham's law. The Richards equation is a fundamental equation for capillary capacity (now called water capacity). This equation governs the isothermal isobaric transport of water through unsaturated soil. Contemporary issues in soil physics are as follows: (1) What are the possible groups of similarity transformations of the Richards equation and how may they be used to classify the behavior of water in soils. (2) What is the most general form of the law of internal energy balance for soil water that is consistent with the Richards equation. (3) What definition of the heating flux density vector will lead to a predictive model of coupled heat and water flow in soil that is both self-consistent and experimentally testable. (4) How does the microscopic or the molecular behavior of water in soil lead to macroscopic transport equations and to the observed values of macroscopic transport coefficient. (See also W88-09405) (Cassar-PTT)
W88-09412

R. E. MOORE AND YOLO LIGHT CLAY,
Geological Survey, Menlo Park, CA.
J. Constantz.
IN: The History of Hydrology. American Geophysical Union, Washington, DC. 1987. p 99-101, 15 ref.

Descriptors: *Standards, *Soil waters, *Groundwater movement, *Geophysics, *Soil properties, *Clays, *History, Yolo light clay, Hydrology, Infiltration, Evaporation, Drainage, Hydraulic conductivity, Unsaturated flow, R.E. Moore, Matric potential, Tensiometers, Sampling.

For half a century the extensive use of the water retention and flow characteristics of Yolo Light Clay has established it as a benchmark soil for comparison of water flow models. The characteristics of Yolo Light Clay have been used to model infiltration, evaporation, drainage, and nonisothermal flow processes by researchers throughout the world. Surprisingly, the actual experimental work involving Yolo Light Clay consists of a single experiment performed by R. E. Moore as part of his dissertation work at the University of California, Berkeley (1934-1937). Furthermore, additional experimental work cannot be performed on Yolo Light Clay because Moore's description of the soil's location is too general for recollection of the original materials. Moore's experiments utilized tensiometers in conjunction with horizontal soil sampling tubes to compare matric potential and water content values in one meter high soil columns during steady evaporation. From these experiments, Moore was able to estimate the relationships between the unsaturated hydraulic conductivity, the matric potential, and the soil water content for Yolo Light Clay and five other soils. By using the word 'light', Moore chose an unorthodox nomenclature for Yolo Light Clay, which now traces all references back to this single experiment. After receiving his PhD in soils, Moore went on to a career as an irrigation engineer for the USDA, primarily in Latin America, and never performed laboratory experiments again. However, during the 1950s the data from one of Moore's experiments with Yolo Light Clay was used as a primary data set in several papers which since became standard references in unsaturated zone hydrology. As a result of these innovative papers, this single data set for Yolo Light Clay is still frequently used as a data base for testing unsaturated soil models. (See also W88-09405) (Author's abstract)
W88-09413

MEASUREMENT OF THE HYDRAULIC CONDUCTIVITY OF FINE-GRAINED SOILS,
Texas Univ. at Austin. Center for Electromechanics.
For primary bibliographic entry see Field 7B.
W88-09436

SUITABILITY OF THERMOCOUPLE PSYCHROMETERS FOR STUDYING MOISTURE MOVEMENT IN UNSATURATED SOILS,
Texas Univ. at Austin. Dept. of Civil Engineering.
D. E. Daniel, J. M. Hamilton, and R. E. Olson.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 84-100, 8 fig, 45 ref, append.

Descriptors: *Thermocouple psychrometers, *Soil water, *Aeration zone, *Unsaturated flow, *Psychrometers, *Soil moisture meters, *Permeability, Groundwater movement, Saturated soil, Hydraulic

properties, Pore pressure, Interstitial water, Psychrometers.

Interest in moisture movement in partially saturated soils has developed rapidly in recent years mainly as a result of increasing use of sites in arid regions for disposal of toxic industrial and radioactive wastes. In attempting to measure hydraulic properties of soils in arid regions, problems are encountered with measurement of large suctions. Accordingly, the possibility of using thermocouple psychrometers, which have a broader range than most other suction probes, for studies of moisture movement in unsaturated soils was investigated. In this paper, the general features of psychrometers are described, procedures for calibration and use are reviewed, and experimental data are presented and discussed. Psychrometric measurements were found to be reproducible within about + or - 10% to 30% over a range in suction of about 2 to 80 atm. Response times were typically less than an hour. Problems with corrosion of psychrometers were severe with strongly acidic soils but not with a basic soil. Independent measurements of suction provided quantitative evidence that psychrometric measurements are reliable. The conclusion is that psychrometers seem to be the most suitable devices now available for measuring suctions in relatively dry, partially saturated soils. (See also W88-09434) (Author's abstract)
W88-09438

PERMEABILITY OF SOILS USING CONTAMINATED PERMEANT,
Woodward-Clyde Consultants, San Francisco, CA.
For primary bibliographic entry see Field 5B.
W88-09439

CORRELATIVE MEASUREMENTS OF PORE SIZE DISTRIBUTION AND PERMEABILITY IN SOILS,
CH2M, Inc., Portland, OR.
I. Garcia-Bengochea, and C. W. Lovell.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 137-150, 6 fig, 2 tb, 24 ref.

Descriptors: *Soil water, *Groundwater movement, *Permeability, *Pore size, Porosity, Clays, Groundwater, Mercury intrusion, Correlation analysis, Mathematical studies.

Measurements and use of pore size distributions to explain the behavior of engineering materials are not new. However, there are few, if any, reports of a simplified methodology and its direct application to engineering predictions. This paper explains how pore size measurements and water permeability can be correlated for compacted samples of saturated clayey silt. The results strongly support the hypothesis that a new generation of permeability prediction equations is now possible. In the new equations, the old soil parameters of effective grain size, total porosity (or void ratio), and specific surface are effectively replaced by appropriate parameters of the pore size distribution. The authors recommend the procedure for compacting, saturating, and permeating fine-grained soil samples. Following the permeability tests, small samples are extracted for constant volume dehydration through a quick freeze-sublimation process. Finally, the mercury intrusion technique is used to quantify the distribution of porosity. Study of the distribution plots, particularly the differential frequency one, is very helpful in (a) qualitatively understanding the experimental results and (b) quantifying the data through statistical correlations. Sample data and plots are introduced to reinforce the principal points of the discussion. (See also W88-09434) (Author's abstract)
W88-09441

IMPERMEABILIZATION OF A 300-HECTARE COOLING POND,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ingenieria.
G. Auvinet, and J. Espinosa.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 151-167, 11 fig, 1 tab, 15 ref.

Descriptors: *Soil water, *Impervious boundaries, *Liners, *Pond liners, *Permeability, *Cooling ponds, Reservoirs, Linings, Clay, Groundwater, Seepage.

The project of the 1200 megawatt Rio Escondido Thermoelectric Plant, now under construction in northern Mexico, includes a 300-hectare (750-acre) cooling pond. The entire reservoir will be created by building a circumferential embankment and developing the total storage requirement above the natural ground level. The makeup water will be obtained at a high cost from the Rio Grande by means of a 30-km-long aqueduct with a maximum capacity of 2.5 cu m/sec. Severe restrictions were put on the allowable seepage. This paper describes the geotechnical investigations performed for evaluation of the subsoil permeability and the final solution adopted: a clay liner compacted according to a nonstandard procedure. Although the use of clay linings to reduce seepage of water storage is an efficient and relatively inexpensive technique, attention must be given to the following points: (1) Some accepted standard permeability tests may be misleading and must be used with care, especially when applied to low-permeability soils; and (2) The structure is the main parameter which controls permeability of a given fine soil. For clayey soils, previous curing, homogenization, and kneading compaction at a water content higher than the Proctor optimum value allow a clear improvement of the results obtained. (See also W88-09434) (Lantz-PTT)
W88-09442

EVALUATING THE SATURATED AND UNSATURATED HYDRAULIC CONDUCTIVITY OF SOILS,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 2F.
W88-09443

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF PARTIALLY SATURATED SOILS,
Law Engineering Testing Co., Houston, TX.
J. M. Hamilton, D. E. Daniel, and R. E. Olson.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 182-196, 9 fig, 11 ref.

Descriptors: *Hydraulic conductivity, *Path of pollutants, *Soil water, *Soil moisture meters, *Instrumentation, *Soil saturation, Psychrometers, Clay, Plasticity, Soil properties, Mathematical studies, Darcy's equation, Permeability, solute transport.

Increased interest in protection of the environment has led to a need to be able to predict long-term movement of moisture, and contaminants, in the vicinity of shallowland disposal sites for various toxic and radioactive wastes. A technique was developed in which thermocouple psychrometers and the instantaneous profile method were used to measure conductivities of soils with suctions as high as 80 atm. For one clay of low plasticity, the conductivity dropped from about 10 to the -7th power cm/sec when saturated to almost 10 to the -12th power cm/sec for degrees of saturation of the order of 30%. Measured conductivities were used in a finite element solution to Darcy's equation to predict final water content profiles. The predicted and measured profiles compared well, which suggests that the measured conductivities were tolerably accurate. Based on data presented, the proposed technique seems promising for conductivity measurements in clays with degrees of saturation between about 30% and 90% and in sands with 5% to 50% saturation. (See also W88-09434) (Lantz-PTT)
W88-09444

ATTENUATION OF RADIONUCLIDES AND TOXIC ELEMENTS BY IN SITU SOILS AT A URANIUM TAILINGS POND IN CENTRAL WYOMING,
D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA.
For primary bibliographic entry see Field 5B.
W88-09447

ANALYSIS OF THE INVERSE PROBLEM FOR TRANSIENT UNSATURATED FLOW,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
J. B. Kool, and J. C. Parker.
Water Resources Research WRERAO, Vol. 24, No. 6, p 817-830, June 1988. 5 fig, 5 tab, 31 ref.

Descriptors: *Soil water, *Unsaturated flow, *Hydraulic properties, Flow characteristics, Infiltration, Evaporation, Hydraulic conductivity, Model studies, Wetting, Mathematical studies.

The inverse problem of determining unsaturated soil hydraulic properties from one-dimensional, transient infiltration and redistribution events was analyzed. Hydraulic properties were assumed to be described by an extension of van Genuchten's model, which allows for hysteresis in the retention function and air entrapment. Unknown parameters in the model were estimated from observed water contents and heads during transient flow by numerical inversion of the unsaturated flow equation. The inverse problem was formulated as a weighted least squares problem and solved using an efficient Levenberg-Marquardt algorithm. The flow event consisted of ponded infiltration followed by gravity drainage with evaporation at the soil surface. Sensitivity analyses indicated that observations during ponded infiltration should be made near the position of the wetting front. The location of observation points during the drying stage was less critical than during the infiltration stage, but for the relatively high imposed evaporative flux sensitivity of pressure head was highest near the soil surface. Large differences in sensitivity were observed among the various model parameters. Unknown evaporative fluxes were approximated in the inverse solution as an equivalent first-type boundary condition requiring only periodic measurements of surface water content during the drying stage. Little error was incurred provided accurate measurements were possible. Corruption of input data with random error was shown to have a larger effect on the predicted conductivity function than on the retention function and more effect on the wetting branch of the hysteretic retention function than on the drying. When measurements are subject to error and the assumed parametric model for water retention and conductivity relations is not exact, it may no longer be possible to detect hysteresis in the retention function. (Author's abstract)
W88-09540

SOIL CONTAMINATION BY SOME ORGANIC MICROPOLLUTANTS RELATED TO SEWAGE SLUDGE SPREADING,
Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. du Genie de l'Environment.
For primary bibliographic entry see Field 5E.
W88-09577

INFLOW-OUTFLOW INFILTRATION MEASUREMENT ACCURACY,
Agricultural Research Service, Kimberly, ID.
T. J. Trout, and B. E. Mackey.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 256-265, May 1988. 3 fig, 7 ref, 2 append.

Descriptors: *Furrow irrigation, *Irrigation, *Flow measurement, *Infiltration rate, *Statistical analysis, Hydraulics, Channel flow, Seepage.

Furrow infiltration and channel seepage are often measured with inflow-outflow measurements. Inaccuracy in the flow measurement will cause a larger uncertainty in the calculated infiltration. The infiltration rate determination uncertainty increases rapidly as the percent of the inflow that is infiltrated decreases. The effect of measurement uncertainty on infiltration measurements can be estimated so that the confidence interval of a mean or the actual infiltration variability level can be determined. (Author's abstract)
W88-09736

SIMPLE METHOD OF OBTAINING SU-BROOKS RETENTION PARAMETERS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
R. J. Lenhard, and R. H. Cuenca.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 363-367, May 1988. 1 fig, 1 tab, 4 ref, append.

Descriptors: *Soil water, *Saturated soils, *Su-Brooks retention function, *Mathematical analysis, Capillarity, Pressure, Saturation, Regression analysis.

In the fields of drainage engineering and soil physics, investigators have sought mathematical functions capable of describing capillary pressure-saturation relations. A method is presented which linearizes the Su-Brooks retention function by transforming the function into logarithmic form. The resulting equation had a form that allows determination of the parameters using linear multiple regression techniques. Although the linearized form did not fit the experimental data as well as when the parameters were determined from a nonlinear regression method, the differences were minor. The greater robustness of a linear regression procedure compared to a nonlinear procedure and the fact that simple hand-held calculators can be employed to determine the parameters makes the linearization procedure an attractive alternative to obtaining Su-Brooks retention parameters compared to nonlinear regression techniques. In addition, the method makes it considerably easier to obtain parameters of the Su-Brooks function compared to the method originally proposed by Su and Brooks and takes all of the experimental data into consideration. (Hammond-PTT)
W88-09747

MORPHOLOGICAL AND CULTURAL COMPARISON OF MICROORGANISMS IN SURFACE SOIL AND SUBSURFACE SEDIMENTS AT A PRISTINE STUDY SITE IN OKLAHOMA,
Florida State Univ., Tallahassee. Dept. of Biological Science.
For primary bibliographic entry see Field 2F.
W88-09793

DISTRIBUTION AND ACTIVITY OF MICROORGANISMS IN SUBSURFACE SEDIMENTS OF A PRISTINE STUDY SITE IN OKLAHOMA,
Cornell Univ., Ithaca, NY. Dept. of Microbiology.
For primary bibliographic entry see Field 2F.
W88-09796

MOVEMENT OF METHYL PARATHION, LINDANE AND ATRAZINE THROUGH LYSIMETERS IN FIELD CONDITIONS,
Ioannina Univ. (Greece). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W88-09904

PREDICTION OF TIME VARIATION IN WATER AND CHLORIDE PROFILES IN A SOIL SUBJECT TO CROPPING AND ANNUAL APPLICATION OF SEWAGE SLUDGE,
National Inst. for Environmental Studies, Tsukuba (Japan). Systems Analysis and Planning Div.
For primary bibliographic entry see Field 5E.
W88-09911

SIMULATION OF RUNOFF AND NITRATE LEACHING FROM AN AGRICULTURAL DISTRICT IN SWEDEN,
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
For primary bibliographic entry see Field 5B.
W88-09913

BOUNDARY-ELEMENT ANALYSIS FOR UNCONFINED SEEPAGE PROBLEMS,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
C. S. Chang.
Journal of Geotechnical Engineering JGEND2, Vol. 114, No. 5, p 556-572, May 1988. 14 fig, 15 ref, 2 append.

Descriptors: *Earth dams, *Dams, * Drawdown, *Seepage, *Reservoirs, *Computer models, *Model studies, Boundary-element analysis, Mathematical analysis.

A boundary-element solution procedure was applied to the analyses of both steady-state and nonsteady-state unconfined seepage problems. These analyses are performed for a laboratory model and prototype earth dams to determine the position of the free surface in a steady-state condition, as well as the movement of the free surface in a transient condition resulting from drawdown of the water level in a reservoir. Applicability of this method is evaluated based on comparisons between the numerical solutions and measured laboratory and field data. (Author's abstract)
W88-09957

PERMEABILITY AND COMPRESSIBILITY OF SLURRIES FROM SEEPAGE-INDUCED CONSOLIDATION,
Universidad Politecnica de Cataluna, Barcelona (Spain).
For primary bibliographic entry see Field 5E.
W88-09958

NITRATE RETENTION AS IT AFFECTS GROUNDWATER POLLUTION IN MID-ATLANTIC SOILS,
Delaware Univ., Newark. Dept. of Plant Science.
For primary bibliographic entry see Field 5B.
W88-10006

MODELING OF SOIL WATER FLOW AND ROOT UPTAKE,
South Dakota State Univ., Brookings. Dept. of Plant Science.
V. Rasiah.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8710636. Ph.D Dissertation, 1986. 91 p, 6 fig, 13 tab, 33 ref.

Descriptors: *Soil water, *Flow discharge, *Mathematical models, *Roots, *Model studies, Permeability coefficient, Water pressure, Absorption, Accumulation, Adsorption, Moisture content.

Soil water flow and root uptake were modeled by solving the flow model numerically for specific initial and boundary conditions. The parameters in the soil water pressure head and hydraulic conductivity functions were estimated to assure that the model agreed with observed data and the parameters in these functions and the root uptake function were also estimated and fitted into the flow model. The simulations for the fitted estimates agreed well with the observed data. The convergence of the estimates in Marguardt's maximum neighborhood method of iterative fitting was more stable than that in the Taylor method. Marquardt's method converged more slowly. The parameters in the root uptake function, estimated and fitted individually for each compartment, produced better solutions than when single function parameters were defined for the whole profile. (Cremmins-AEPCO)
W88-10076

2H. Lakes

PRELIMINARY ASSESSMENT OF THE IMPORTANCE OF LITTORAL AND BENTHIC AUTOTROPHIC COMMUNITIES IN ACIDIC LAKES,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
T. L. Crisman, C. L. Clarkson, A. E. Keller, R. A. Garren, and R. W. Bienert.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 17-27, 1 fig, 72 ref.

Descriptors: *Acidic waters, *Lakes, *Littoral environment, *Autotrophs, *Acid rain effects, *Benthos, *Limnology, *Ecosystems, Assessments, Phytoplankton, Acid rain, Lake morphology, Nutrients.

Most of the research examining changes in aquatic biota relative to increasing acidity has concentrated on pelagic components. The possible influence of littoral-pelagic interactions on observed relationships has largely been ignored, and thus interpretation of pelagic biotic data often is taken out of context of the whole ecosystem. While littoral and benthic communities are major contributors to the autotrophic production of small lakes in general, it is likely that their share assumes greater importance in acidic lakes where phytoplankton are often severely nutrient-limited. The availability of nutrients in the pelagic zone of acidic lakes may be regulated by littoral and benthic processes. Available data suggest that while the structure of littoral and benthic autotrophic communities has a direct influence on benthic invertebrates, it exerts an indirect control on zooplankton and fish principally through the quality and quantity of habitat and food resources. Future investigations of biota in acidic soft-water lakes should concentrate on quantifying such littoral-pelagic linkages. (See also W88-08960) (Author's abstract)
W88-08962

EFFECTS OF SHORT-TERM AND CONTINUOUS EXPERIMENTAL ACIDIFICATION ON BIOMASS AND PRODUCTIVITY OF RUNNING WATER PERIPHYTIC ALGAE,
Quebec Univ., Montreal. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W88-08963

RELATIONSHIPS OF SPATIAL GRADIENTS OF PRIMARY PRODUCTION, BUFFERING CAPACITY, AND HYDROLOGY IN TURKEY LAKES WATERSHED,
National Water Research Inst., Burlington (Ontario).
D. C. L. Lam, A. G. Bobba, D. S. Jeffries, and J. M. R. Kelso.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 42-53, 6 fig, 1 tab, 23 ref.

Descriptors: *Lakes, *Acid rain effects, *Small watersheds, *Primary productivity, *Hydrogen ion concentration, *Hydrologic studies, *Turkey Lakes, *Ontario, Phytoplankton, Carbon, Alkalinity, Algae, Watersheds, Acidification, Soil water, Groundwater, Acid rain, Limnology, Surface-groundwater relations, Spatial distribution.

The carbon uptake rate of phytoplankton was found to increase from poorly buffered, headwater lakes to better buffered, downstream lakes in the Turkey Lakes Watershed near Sault Ste. Marie, Ontario, Canada. While the nutrient, sunlight, and temperature conditions remained fairly uniform, the pH, alkalinity, and dissolved inorganic carbon concentration increased in a similar manner as the primary production. Relationships of these spatial

gradients and their probable causes are discussed for a small watershed (area = 10.5 sq km). In particular, results from a hydrological model show that more groundwater flowed into downstream lakes than headwater lakes. The greater soil-water contact time and the higher concentration of calcium carbonate (CaCO3) present in the till at low-lying areas cause the introduction of relatively greater quantities of Ca(2+) and alkalinity into the downstream lakes. Thus, the development of acidification-eutrophication models must incorporate the physical, chemical, and biological processes for both soil and water. (See also W88-08960) (Author's abstract)
W88-08964

SIZE-DEPENDENT SENSITIVITY OF THREE SPECIES OF STREAM INVERTEBRATES TO PH DEPRESSION,
Michigan State Univ., East Lansing. Dept. of Zoology.
J. W. Allan, and T. M. Burton.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 54-66, 9 fig, 22 ref.

Descriptors: *Stream biota, *Animal growth, *Acid rain effects, Acid rain, *Toxicity, *Hydrogen ion concentration, *Invertebrates, *Water pollution effects, Caddisflies, Isopods, Snails, Acidic waters, Sulfuric acid, Acidification, Nitric acid, Lethal limits, Eggs, Larvae, Limnology.

Three species of stream invertebrates, the caddisfly Lepidostoma liba (Ross), the isopod (Asellus intermedius (Forbes), and the snail Physella heterostropha (Say), were found to be highly vulnerable to depression to pH 4.0 with 70% sulfuric acid (H2SO3) and 30% nitric acid (HNO3) from a control pH of 6.7 to 7.2. This vulnerability was directly correlated to size with smaller individuals being much less tolerant to pH depression than were larger individuals. Smaller size classes, including egg masses of P. heterostropha, were totally eliminated by exposure to pH 4. Survival increased as initial body mass increased past a threshold size (0.5 mg dry weight/individual for A. intermedius, 0.6 mg for L. liba, and at a shell length of 4 mm for P. heterostropha). Depression of pH from 7 to 4 also depressed growth rates for A. intermedius, and L. liba. This experiment was conducted in recirculating laboratory streams operated near ambient temperatures. After complete mortality in any channel or at 8-week intervals (whichever came first), previous experimental animals were discarded and ten new individuals for each replicate for each species were placed in the cages in each stream. (See also W88-08960) (Author's abstract)
W88-08965

BUFFERING CAPACITY OF SOFT-WATER LAKE SEDIMENTS IN FLORIDA,
Minnesota Univ., Minneapolis. Dept. of Civil and Mining Engineering.
T. E. Perry, C. D. Pollman, and P. L. Brezonik.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 67-83, 7 fig, 3 tab, 17 ref.

Descriptors: *Acid rain effects, *Alkaline water, *Limnology, *Lake sediments, *Florida, *Buffering, Hydrogen ion concentration, Sulfuric acid, Lake chemistry, Neutralization, Organic matter, Chemical analysis, Sulfates, Acid rain.

Fifty sediment cores from 13 soft-water lakes in north- and south-central Florida were collected to examine the role of surficial sediments in buffering lake water against changes in pH induced by additions of sulfuric acid (H2SO4). Results from batch bottle experiments showed higher pH values in sediment-water slurries than corresponding lake water pH, suggesting that chemical processes in the sediments tend to counter inputs of acidity to the water column. The acid-neutralizing capacity (ANC) was moderately related to organic content; consequently, ANC was more pronounced in pelagic sediments, which typically accrete organic matter, than littoral sediments, which are more subject to wind-induced scour and resuspension and characteristically are impoverished in organic matter. Calculated areal buffering capacities from the batch studies ranged from 5.5 to 149 meq/sq m/cm, indicating that sufficient buffering is available in 1 to 2 cm of sediment to neutralize annual proton loadings via ion exchange alone. Significant neutralization of acid inputs also was observed in intact cores, and analysis of changes in cation chemistry in the overlying water of the cores suggests that microbially mediated sulfate reduction exceeded ion exchange as the principal alkalinity-producing mechanism. High rates of sulfate removal from the experimental cores support this conclusion; sulfate losses ranged from 32 to 94% in pelagic cores and 39 to 91% in littoral cores. Cores that received no acid showed losses of sulfate ranging from 55 to nearly 100% with concomitant increases in pH in the overlying water. Neutralization of added acid directly attributable to the sediments ranged from 31.8 to 101 meq/sq m over the 4-month duration of the study. Neutralization was independent of particle size distribution or sediment organic content. (See also W88-08960) (Lantz-PTT)
W88-08966

1987 ANNUAL BOOK OF ASTM STANDARDS.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 7B.
W88-08988

PHOSPHATE DYNAMICS IN AQUATIC ECOSYSTEMS,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5C.
W88-09050

PREDICTING THE TROPHIC STATUS OF RESERVOIRS IN SEMI-ARID REGIONS,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5C.
W88-09051

LAKE SEDIMENTS AS HISTORIC RECORDS OF ATMOSPHERIC CONTAMINATION BY ORGANIC CHEMICALS,
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
For primary bibliographic entry see Field 5B.
W88-09068

MECHANISMS CONTROLLING THE DISTRIBUTION OF TRACE ELEMENTS IN OCEANS AND LAKES,
Washington Univ., Seattle. School of Oceanography.
J. W. Murray.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 153-184, 12 fig, 1 tab, 101 ref.

Descriptors: *Trace elements, *Lakes, *Lake sediments, *Mixing, *Limnology, Distribution patterns, Chemical reactions, Ocean circulation, Lake morphometry, Path of pollutants, Spatial distribution, Cycling nutrients, Oceanography, Sampling, Washington, Switzerland, Lake Zurich, Lake Washington.

Many of the same mechanisms that control the distribution of trace elements in the ocean are also important in lakes. Specifically, these include nutrient-like biological recycling, sediment fluxes, oxidation-reduction cycling, and scavenging by particles. The influence of each of these mechanisms can be seen in the trace element profiles of lakes despite the fact that lakes are intrinsically much more difficult to study than oceans. This difficulty arises because: (1) lakes are not at steady state, and the magnitude of the controlling mechanisms varies with time; and (2) the large sediment-to-water-volume (sediment-volume) ratios, together with rapid horizontal mixing, result in sediment fluxes that tend to mask the other processes. Nevertheless, lakes are more accessible and in most cases easier to sample than the ocean. Because of the wide variety in types of lakes, isolating variables is possible by choosing the lake with the right properties. Examples of different processes are illustrated by using new trace element data from Lake Zurich and Lake Washington. (See also W88-09065) (Author's abstract)
W88-09071

METAL SPECIATION IN NATURAL WATERS: INFLUENCE OF ENVIRONMENTAL ACIDIFICATION,
Quebec Univ., Sainte-Foy.
For primary bibliographic entry see Field 5C.
W88-09072

ION BUDGETS IN A SEEPAGE LAKE,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
J. C. Lin, J. L. Schnoor, and G. E. Glass.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 209-227, 7 fig, 4 tab, 17 ref.

Descriptors: *Lakes, *Alkalinity, *Seepage lakes, *Water chemistry, *Limnology, *Ions, *Nitrogen, Ammonia, Nitrates, Sulfates, Chemical reactions, Hydrologic models, Chemical properties, Acidity, Hydrogen ion concentration, Hydrologic budget, Biological degradation, Biomass, Ion exchange, Kaolinite, Trickle-down model, Model studies, Seepage, Vandercook Lake, Wisconsin, Anions, Cations.

On the basis of an existing hydrologic model (trickle-down model), an ion budgets approach was applied to study the internal processes of Vandercook Lake in Wisconsin. The results indicated that alkalinity was produced by in-lake processes. Nitrogen transformations were significant, but their role in the acid-base budget was negligible because the acidifying influence of the ammonium loss was roughly balanced by the alkalizing effect of the nitrate loss. Sulfate reduction was important and accounted for 54% of the alkalinity production. (See also W88-09065) (Author's abstract)
W88-09073

MECHANISMS OF ALKALINITY GENERATION IN ACID-SENSITIVE SOFT WATER LAKES,
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
For primary bibliographic entry see Field 5C.
W88-09074

HYDROPHOBIC ORGANIC COMPOUNDS ON SEDIMENTS: EQUILIBRIA AND KINETICS OF SORPTION,
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
For primary bibliographic entry see Field 5B.
W88-09075

ROLE OF PARTICULATE MATTER IN THE MOVEMENT OF CONTAMINANTS IN THE GREAT LAKES,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W88-09076

SEDIMENTS AS ARCHIVES OF ENVIRONMENTAL POLLUTION TRENDS,
Indiana Univ., Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 5B.
W88-09077

CHEMICAL LIMNOLOGY OF NONPOLAR ORGANIC CONTAMINANTS: POLYCHLORINATED BIPHENYLS IN LAKE SUPERIOR,
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
For primary bibliographic entry see Field 5B.
W88-09078

FATE OF SOME CHLOROBENZENES FROM THE NIAGARA RIVER IN LAKE ONTARIO,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
For primary bibliographic entry see Field 5B.
W88-09079

CYCLES OF NUTRIENT ELEMENTS, HYDROPHOBIC ORGANIC COMPOUNDS, AND METALS IN CRYSTAL LAKE,
Wisconsin Univ.-Madison. Water Chemistry Program.
For primary bibliographic entry see Field 5B.
W88-09080

ELEMENT CYCLING IN WETLANDS: INTERACTIONS WITH PHYSICAL MASS TRANSPORT,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
H. F. Hemond, T. P. Army, W. K. Nuttle, and D. G. Chen.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 519-537, 9 fig, 1 tab, 20 ref.

Descriptors: *Wetlands, *Cycling nutrients, *Geochemistry, *Limnology, *Soluble transport, Sediment transport, Hydrologic models, Physical properties, Marshes, Peat bogs, Mathematical models, Recycling, Marine sediments, Biological properties, Chemical reactions, Advection, Diffusion, Vapor-phase transport, Belle Isle Marsh, Thoreau's Bog, Massachusetts.

In peatlands and other waterlogged ecosystems, a severely restricted physical transport regime may be regarded as a rate-controlling factor for many biogeochemical processes. Transport in the liquid phase by advection, diffusion, and dispersion, and vapor-phase transport by ebullition and desaturation are the abiotic transport processes in wetland sediments. Biotic transport may also occur. Quantitative formulations for several of these transport processes exist, and specific, quantitative, useful examples of transport-oriented biogeochemical cycles are presented for two wetland ecosystems, namely, Belle Isle marsh and Thoreau's Bog, both in Massachusetts. (See also W88-09065) (Author's abstract)
W88-09081

METAL AND RADIONUCLIDE CONCENTRATIONS IN L-LAKE SEDIMENTS,
For primary bibliographic entry see Field 5B.
W88-09212

INVENTORIES OF 137-CS, 90-SR AND 239,240-PU IN POND B: IMPLICATIONS FOR THE RELATIVE IMPORTANCES OF RADIONUCLIDE CYCLING PROCESSES IN LAKE ECOSYSTEMS,
For primary bibliographic entry see Field 5B.
W88-09214

WETLAND FOREST REGENERATION AND HYDROLOGIC REGIME,
R. R. Sharitz, R. L. Schneider, K. W. Dyer, and N. C. Martin.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 47-53, 4 fig, 2 tab.

Descriptors: *Flood plains, *Wetlands, *Forests, *Hydrologic budget, *Revegetation, Swamps, Cypress, Water tupelo, Seeds, Germination, Savannah River, South Carolina.

Major factors that limit regeneration of bald cypress and water tupelo include: (1) low seed production, viability, and dispersal; (2) lack of suitable substrates for germination; and (3) hydrologic conditions that limit germination and seedling survivorship. An evaluation of the relative importance of these factors on regeneration success of bald cypress and water tupelo in the 3800-ha Savannah River floodplain forest on the SRP has been conducted from 1984-1986. Total seed production and seed viability patterns differed between species and among years. In 1984, water tupelo seed production averaged 42 seeds shed/sq m in the floodplain forest. Bald cypress produced 25 seeds/sq m in 1984. In 1985, water tupelo produced 128 seeds/sq m, three times more than the previous season; bald cypress experienced a mast seed production year, and averaged 433 seeds/sq m. Limited seed viability, however, lowered the regeneration potential in both years. The hydrologic environment has a major influence on the process and outcome of woody seed dispersal. Bald cypress seeds were shed from August through April; water tupelo seeds fell from June through February. Peak seed fall coincided with, or slightly preceded, the early spring water level rise in the SRP Savannah River floodplain. Hydrologic conditions also influence the retention of seeds in an area, the distances and directions seeds travel, and final seed distributions. Increased water depth was associated with increased surface velocity and decreased availability of emergent substrates that trap seeds. Thus, even small increases in water levels during these critical dispersal months may have a major impact on overall seed availability. Floods of the SRP Savannah River were defined to be water levels exceeding mean annual base flow level by 1/2 the standard deviation (>32 cm). Such floods occur when river flows exceed 15,500 cu ft/s. Four flood events were recorded during 1984, two of them during the growing season. Model studies suggest that the Savannah River is not the only factor affecting swamp water levels. The river exerts the strongest influence only during relatively high flow (> 15,500 cfs). During low river flow, swamp water level is more likely to be determined by base flows in the tributary streams, and by the timing of reactor operations. (See also W88-09211) (Lantz-PTT)
W88-09219

REVEGETATION OF STEEL CREEK DELTA AND CORRIDOR,
C. P. Dunn, R. Kelly, and R. R. Sharitz.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 54-57, 3 fig.

Descriptors: *Water pollution effects, *Revegetation, *Steel Creek, South Carolina, Wetlands, Cypress, Water tupelo, Environmental effects, Thermal pollution, Surveys, Savannah River Plant, Nuclear reactors.

While L-Reactor was operational, from 1954-1968, cooling water from the Savannah River Plant was released into Steel Creek. This hot water (up to 70 C) killed much of he existing vegetation (mostly bald cypress-tupelo forested wetland). From 1954-1963, P-Reactor also discharged thermal effluent into Steel Creek. The volume of water discharged from the reactors greatly exceeded the natural volume (0.4 cu m/s; 14 cfs). As a result, the stream channel was scoured and sediment was deposited as an alluvial fan at the mouth of the creek. The thermal effluent, altered hydrology, and sediment deposition combined to form an area of degraded wetland vegetation. Since 1968, when L-Reactor was taken off line, water flow in Steel Creek returned to approximately natural levels. In addition, the corridor and delta wetlands began to revegetate. The wetland vegetation of Steel Creek was resurveyed in the fall of 1985 as part of a baseline study to assess potential environmental impacts associated with the restart of L-Reactor. This report describes the vegetation of Steel Creek delta and corridor as of 1985 and documents vegetation changes in these areas. The earliest study of Steel Creek revegetation was completed in 1972; therefore, 13 years of vegetation data for portions of Steel Creek are available. This permits analysis of revegetation trends in a degraded forested wetland and speculation as to the possible return to a bald cypress-tupelo forest. (See also W88-09211) (Lantz-PTT)
W88-09220

RESPONSE OF WETLAND HERBACEOUS COMMUNITIES TO GRADIENTS OF DISTURBANCE, LIGHT, AND SUBSTRATE,
M. L. Scott, and V. P. Dunn.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 58-62, 2 fig, 1 tab.

Descriptors: *Plant populations, *Flooding, *Wetlands, *Vegetation, *Light, *Substrates, Water temperature, Water pollution effects, Water level, Flood plains, Water depth, Steel Creek, South Carolina, Savannah River Plants, Nuclear industry.

Beginning in the 1950's, cooling water from the Savannah River was passed through heat exchangers in the reactors and discharged into three tributary streams including Pen Branch and Steel Creek. Past and present disturbances influence the distributions of herbaceous assemblages in this wetland. Elevation is commonly used as an indicator of flooding, which may be considered a disturbance or perturbation in floodplain forests. Although this wetland is subjected to periodic flooding, water is a permanent feature of large portions. Water depth is strongly associated with species composition across all sites and appears to reflect species differences between inundated and emergent plots. When all sites in this study are pooled, light (representing disturbance to the forest canopy) is a significant environmental factor associated with both detrended-correspondence-analysis ordination axes. Disturbance, then, is important in accounting for inter-site (coarse scale) differences in herbaceous species composition. Within-site (fine scale) differences in species composition, however, are best explained by substrate conditions or water depth. (Lantz-PTT)
W88-09221

USE OF MULTIPLE STABLE ISOTOPES TO DISCRIMINATE AMONG SOURCES OF ALLOCHTHONOUS ORGANIC MATERIAL,
J. V. McArthur, and M. L. Scott.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 68-72, 3 fig, 1 tab.

Descriptors: *Stream biota, *Coastal plains, *Isotope studies, *Allochthonous material, *Organic matter, *Carbon radioisotopes, *Food chains, Nitrogen, Sulfur, Southeastern United States, Isotopes.

Although stable isotopes effectively resolve differences among broad categories of organic matter (e.g., between C-3 and C-4 plants), use of multiple stable isotopes to discriminate among organic matter sources within such categories has not been reported. This study shows that stable isotopes can be used to discriminate among sources of allochthonous organic matter from a group of C-3 plants that form the dominant riparian vegetation of many coastal plain streams in the southeastern United States. The ability to discriminate among sources of allochthonous material allows determination of possible food web linkages in aquatic systems. Resolution of these linkages requires measurements of all possible sources of food, both allochthonous and autochthonous. Such a comprehensive sampling scheme was beyond the scope of this preliminary study. Nevertheless, measurements of the isotopic ratios of carbon, nitrogen and sulfur in two species of freshwater clams suggest that this technique can determine possible food sources from within a group of C-3 plants. (See also W88-09211) (Lantz-PTT)
W88-09223

SEDIMENT INSTABILITY AND WOODY SEEDLING GROWTH,
For primary bibliographic entry see Field 5C.
W88-09224

MANAGEMENT PLAN FOR ESTABLISHMENT OF LITTORAL/WETLAND VEGETATION AT L-LAKE,
For primary bibliographic entry see Field 5G.
W88-09226

LARVAL FISH ASSEMBLAGES ALONG REACTOR THERMAL PLUMES IN A RIVERINE SWAMP SYSTEM,
For primary bibliographic entry see Field 5C.
W88-09228

HABITAT ASSOCIATION OF FISH ASSEMBLAGES IN SMALL STREAMS OF THE SRP,
G. K. Meffe, and A. L. Sheldon.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 104-110, 4 fig, 2 tab.

Descriptors: *Fish, *Species composition, *Habitats, *Savannah River Plant, *Streams, *Fish populations, Flow velocity, Ecosystems, Environmental effects, Ecological effects, Baseline studies.

Southeastern blackwater streams of the Atlantic Coastal Plain have been virtually unstudied with respect to fish community structure. On the Savannah River Plant (SRP) this is particularly unfortunate since local streams, which have been perturbed by nuclear activities, cannot be quantitatively compared with normal systems to determine extent of community disruption or to minimize impact. This paper presents descriptive, quantitative information on fish community structure in natural streams of the SRP relative to habitat components, for use in assessment of damage to impacted streams and in management of and mitigation for these sites. Variance in local fish assemblage structure in the low gradient blackwater systems on the SRP is largely attributable to differences in current velocity and habitat size (primarily depth but also width) and associated covariates such as substrate type and cover components. Current velocity and stream depth together are good predictors of the types and numbers of species to be found at a given site. Three independent analytical techniques, principal components analysis of habitat data, detrended correspondence analysis of fish distributional information, and path analysis all indicate that current velocity and stream size are the major factors that describe variation in local assemblage structure. These are good descriptive tools for understanding the role of habitat structure in SRP fish assemblage structure. This model of fish-habitat relationships also can predict impacts of changes in current velocity or discharge on individual SRP fishes and on fish communities at large. (See also W88-09211) (Lantz-PTT)
W88-09229

BIOMASS PRODUCTIVITY OF FRESHWATER TURTLES,
J. D. Congdon, and J. W. Gibbons.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 111-114, 1 tab.

Descriptors: *Wetlands, *Turtles, *Biomass, *Productivity, South Carolina, Michigan, Marshes, Swamps, Aquatic animals, Eggs, Soma, Wetlands, Ecology.

The biomass production of both soma and eggs of a six-species turtle community from a Carolina bay on the Savannah River Plant (SRP) was compared with that of a three-species turtle community in a marsh in southeastern Michigan. This study assesses the role and importance of freshwater turtles in natural wetland habitats. Four major problems that affect the precision of estimating standing crop biomass of turtles also influence the precision of estimating biomass production. These include accurate determinations of: (1) adult sex ratios; (2) degree of sexual size dimorphism; (3) numbers of adults of both sexes and of juveniles of each species in the community; and (4) size of the aquatic habitat. Two additional estimates must be made to accurately determine biomass productivity. These are: (1) juvenile growth rates, because they are faster than those of adults, and (2) growth rates of older adults compared with younger ones because growth appears to continue, though very slowly, in older adults of many species of turtles. Old mature populations generally have high standing crop biomass relative to biomass production rates; turtles seem to follow this pattern. While biomass production rates of turtles in southern and northern marshes may account for a very small portion of the total production of marshes and swamps, turtles can be an important component of wetlands fauna as vectors that allow organisms such as algae, plants and leeches to invade new wetland habitats. Turtles, in contrast to fish and other purely aquatic organisms, are capable of terrestrial migrations that allow them to invade temporary or newly formed wetlands. Wetlands have been recognized as essential habitats for many endangered or threatened species of animals and plants, as well as for species that do not have legal protection status, such as most freshwater turtles. This is especially true for populations of species such as the snapping turtle that must sustain not only loss of wetland habitat but also commercial harvesting pressures. The low biomass production rates of soma coupled with high predation rates of eggs indicate that populations suffering prolonged harvesting for meat, even at relatively low levels, cannot be sustained by recruitment and individual body growth. This, coupled with potential wetland degradation, suggests that a careful view should be taken toward laws that regulate the removal of such key components of wetland habitats. (See also W88-09211) (Lantz-PTT)
W88-09230

EFFECTS OF THE 1985 DROUGHT ON BREEDING AND FORAGING ECOLOGY OF WOOD STORKS IN EAST-CENTRAL GEORGIA,
M. C. Coulter.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 126-129, 1 fig, 1 tab.

Descriptors: *Wetlands, *Drought, *Breeding, *Ecology, *Storks, *Georgia, *Ecological effects, *Georgia, Evaporation, Rainfall, Population dynamics, Food, Predation, Ecosystems, Raccoons, Alligators, Water birds.

Wood storks are tactile-feeding wading birds. During the breeding season they depend on high densities of aquatic prey to obtain sufficient food for themselves and their young. The densities and population dynamics of their prey are greatly affected by the evaporation and rainfall regime. During dry periods evaporation may lower water levels and concentrate prey in small ponds. A severe drought occurred in 1985 in east-central Georgia. The breeding biology and foraging ecology of wood storks at a rookery in Millen, Georgia were studied, and compared with observations from 1984, a very wet year. During the 1985 drought, the wood storks from the rookery raised only 0.3 fledglings per nest. This was considerably lower than in 1984, which was a very wet year. The average maximum number of young per nest, an indication of the number of eggs laid, was also lower. In addition, many young died during the summer. Much of the loss of chicks can be attributed to the drought conditions. The food resource was reduced. Not only were there fewer foraging areas, but prey densities were lower as well. In addition, raccoon predation can be attributed to the drought. During wetter years, raccoons have difficulty reaching stork colonies (which are always built over water). Alligators frequent these areas and are an additional deterrent to raccoons. It is significant that the rookery failed in 1981, which was also a drought year. (See also W88-09211) (Lantz-PTT)
W88-09233

ECOLOGY OF WATERFOWL POPULATIONS ON THE SRP,
G. R. Hepp, R. A. Kennamer, and R. T. Hoppe.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 130-134, 3 fig, 2 tab.

Descriptors: *Wetlands, *Ecology, *Waterfowl, *Population dynamics, Seasonal variation, Water birds, Ducks, Migration, Thermal effects, Population dynamics, Surveys, Long-term studies, Savannah River Plant, South Carolina, Nuclear industry.

Waterfowl are major primary and secondary consumers in wetlands of the Savannah River Plant (SRP), and are also economically important as popularly harvested game species. Additionally, because of their migratory nature, they are of concern to the operation of the SRP as potential vectors of radionuclides off the site. Waterfowl use the SRP during two distinct time periods: (1) from mid-autumn until early spring several species of migratory waterfowl use the area; and (2) during spring and summer breeding wood ducks, Aix sponsa, use the SRP. The Savannah River Ecology Laboratory is currently conducting two long-term waterfowl research projects. The first is an assessment of waterfowl use of the SRP during the wintering season. The second project is a study of the breeding ecology of wood ducks in a post-thermal drainage system. General waterfowl use of the site during the fall and winter period was assessed by aerial surveys and roost count. Aerial surveys showed that 17 species of waterfowl occurred on the Par Pond Reservoir System (PPRS). Mallards and wood ducks were the most abundant species in the Savannah River Swamp System (SRSS) during aerial surveys. Peak number of mallards occurred in early March; wood ducks numbers were relatively constant during the fall and winter. Roost counts, which supplemented the aerial survey in the SRSS, indicated that mallards and wood ducks were the dominant waterfowl species in the SRSS with peak totals occurring in January. (See also W88-09211) (Lantz-PTT)
W88-09234

GEOCHEMISTRY OF NATURAL WATERS,
Wyoming Univ., Laramie.
For primary bibliographic entry see Field 2K.
W88-09235

MONO BASIN GEOLOGY AND HYDROLOGY,
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 2A.
W88-09276

RESTORATION ECOLOGY: THE NEW FRONTIER,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 5G.
W88-09449

RIVER AND STREAM RESTORATION,
Tulsa Univ., OK. Faculty of Biological Science.
For primary bibliographic entry see Field 5G.
W88-09450

TECHNIQUES FOR THE CREATION OF WETLAND HABITAT IN COAL SLURRY PONDS,
Restoration Resources, Inc., Indianapolis, IN.
For primary bibliographic entry see Field 5G.
W88-09453

EVALUATION OF STRIP PITS AND PONDS FOR PHYSICAL MANIPULATION TO INCREASE WETLANDS AND IMPROVE HABITAT IN SOUTHWESTERN INDIANA,
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
D. E. Willard.
IN: Rehabilitating Damaged Ecosystems. Volume I. CRC Press Inc., Boca Raton, Florida. 1988. p 115-122, 3 fig, 11 ref.

Descriptors: *Wetlands, *Restoration, *Wetland management, *Strip mines, *Wildlife habitat, *Ponds, *Regional planning, *Indiana, Coal mines, Wildlife, Ecosystems, Economic aspects, Legislation, Lakes.

Three general areas of wetland management: (1) the availability of coal mining-generated water bodies, particularly wetlands, for fish and wildlife

habitat; (2) the potential use of wetlands for fish and wildlife; and (3) the role of natural succession in the wetlands, are discussed in this paper. Embedded in these scientific topics are discussions of the role of cumulative regional additions to the wetland acreage of Indiana as mitigation for past large losses of wetlands. Finally, the author argues that scientists now have the expertise, interest, and financial resources to expand development of wetlands and other aquatic resources in the mined areas of southwestern Indiana. National and state interest now focuses on restoration of wetlands, development of new wetlands, and mitigation of wetland loss. The draft research plan of the U.S. Environmental Protection Agency emphasizes these areas and adds the effects of cumulative wetland loss and gain. In 1985, the Indiana legislature authorized the expenditure of a $350,000 match to U.S. Fish and Wildlife Service funds to complete the National Wetlands Inventory of Southwest Indiana, an area including the mine-caused lakes also discussed here. (See also W88-09438) (Lantz-PTT)
W88-09454

RESTORATION AND MANAGEMENT OF ECOSYSTEMS FOR NATURE CONSERVATION IN WEST GERMANY,
Stuttgart Univ. (Germany, F.R.). Inst. fuer Landschaftsplanung.
For primary bibliographic entry see Field 5G.
W88-09456

REHABILITATING DAMAGED ECOSYSTEMS.
For primary bibliographic entry see Field 5G.
W88-09457

RE-CREATION OF ECOSYSTEMS AT MOUNT ST. HELENS: CONTRASTS IN ARTIFICIAL AND NATURAL APPROACHES,
Washington Univ., Seattle. Coll. of Forest Resources.
For primary bibliographic entry see Field 5G.
W88-09458

ALTERNATIVE ENDPOINTS FOR RECLAMATION,
Liverpool Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 6A.
W88-09459

REHABILITATING ECOSYSTEMS AT HIGH ALTITUDES,
Western State Coll. of Colorado, Gunnison.
For primary bibliographic entry see Field 5G.
W88-09462

METHODS OF RECOVERING VIRUSES FROM AQUATIC SEDIMENTS,
Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
For primary bibliographic entry see Field 5A.
W88-09465

MODELS OF SORPTIVE TOXIC SUBSTANCES: II. LAKES AND RESERVOIRS,
Manhattan Coll., Bronx, NY. Dept. of Environmental Engineering and Science.
For primary bibliographic entry see Field 5B.
W88-09523

POTENTIAL FOR FISHERIES REHABILITATION IN THE HAMILTON HARBOUR-COOTES PARADISE ECOSYSTEM OF LAKE ONTARIO,
Toronto Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 5G.
W88-09546

MUNICIPAL LAND USE REGULATION AND THE GREAT LAKES SHORELINE HAZARD IN ONTARIO,
Guelph Univ. (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 6F.
W88-09547

HETEROTROPHIC GLUCOSE ASSIMILATION IN LAKE ONTARIO,
Windsor Univ. (Ontario). Dept. of Biology.
G. D. Haffner, M. L. Yallop, and P. D. N. Hebert.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 157-163, 1988. 2 fig, 2 tab, 20 ref.

Descriptors: *Lakes, *Glucose, *Phytoplankton, *Algae, *Productivity, Bacteria, Photosynthesis, Carbon, Organic carbon, Heterotrophic bacteria, Great Lakes, Lake Ontario.

Heterotrophic glucose uptake was measured during 1980 in Lake Ontario plankton populations. Uptake rates of glucose were generally low (0.003 to 0.457 mg C/cu m/h) compared with corresponding photosynthetic carbon uptake (8 to 32 mg C/cu m/h). Particle size fractionation studies confirmed that a majority of heterotrophic carbon uptake was in the 1 to 8-micron diameter size class. Although heterotrophic carbon utilization by algae and bacteria was small when directly compared with photosynthetic production, heterotrophy might contribute significantly to the carbon flux within a water column over a 24-hour period. (Author's abstract)
W88-09549

ALGAL REMAINS IN SOME SURFACE SEDIMENTS OF LAKE ERIE,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
T. J. Keilty, E. F. Stoermer, and D. S. White.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 164-170, 1988. 3 fig, 2 tab, 29 ref. EPA Grant R-813831.

Descriptors: *Lakes, *Algae, *Sediments, Lake sediments, Diatoms, Lake Erie, Great Lakes, Paleolimnology.

Algal remains, primarily diatoms, were examined in the 0-1 cm fraction of sediment cores collected at eight stations along a west-to-east transect in Lake Erie to determine species composition, cell density, and flux rates. Sixty-two taxa were identified of which 13 were common to all stations. Highest densities and flux rates occurred in the western and eastern basins. Species composition, cell density, and flux rates in the sediments did not appear to correlate well with previous reports of water-column phytoplankton distribution and abundance. The distribution of diatom remains in the sediments more likely resulted form the effects of near-bottom west-to-east energy zones and transport mechanisms operating within the western and central basins of Lake Erie. The distribution of algal remains demonstrated that caution should be used in applying paleolimnological data to trophic status changes in Lake Erie. (Author's abstract)
W88-09550

EPHEMERA AND HEXAGENIA (EPHEMERIDAE, EPHEMEROPTERA) IN THE STRAITS OF MACKINAC, 1955-1956,
North Carolina State Univ., Raleigh. Dept. of Zoology.
S. C. Mozley, and R. M. LaDronka.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 171-177, 1988. 5 fig, 26 ref.

Descriptors: *Lakes, *Aquatic insects, *Great Lakes, Mayflies, Insects, Straits of Mackinac, Lake Michigan, Lake Huron, Hexagenia.

Rediscovered material from an extensive sediment survey in the Straits of Mackinac and adjacent parts of Lakes Michigan and Huron provides one of the earliest quantitative distributional records of mayflies in the main basins of the Great Lakes. About 300 sites were sampled once each during two summers for macrobenthos, as well as for sediment textural characteristics. Mayflies from the survey were either Ephemera (probably E. simulans) or Hexagenia (at least partly H. limbata), and occurred primarily at depths less than 20 m but up to 66 m. Both taxa were restricted to sand, silty, sand, or sandy silt bottoms, and occurred more frequently in the Lake Michigan and southern Lake Huron parts of the study area than in the northern Lake Huron part of the Straits. Limited data on body length frequencies indicate a life cycle longer than 2 years for at least part of the Hexagenia population. Areas of low densities were related to lower temperatures and indicators of low pelagic primary production. Absence of ephemerids from several subsequent surveys of parts of the study area raises the possibility that mayflies have disappeared from the Straits since 1956. (Author's abstract)
W88-09551

GUT FULLNESS OF THE DEPOSIT-FEEDING AMPHIPOD, PONTOPOREIA HOYI, IN SOUTHEASTERN LAKE MICHIGAN,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
M. A. Quigley.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 178-187, 1988. 5 fig, 1 tab, 58 ref.

Descriptors: *Lakes, *Benthic fauna, *Food habits, Sediments, Lake sediments, Amphipods, Pontoporeia hoyi, Lake Michigan, Great Lakes, Detritus, Phytoplankton.

Pontoporeia hoyi Smith, a deposit-feeding amphipod and a prominent member of the Great Lakes macrobenthic community, was collected at a 45-m-deep site in southeastern Lake Michigan during October 1983 and March, May, June, August, and September 1984. Substantial numbers of animals with empty or partially-full guts indicated that P. hoyi feeds intermittently, unlike other continuous-feeding amphipods which routinely maintain uniformly full guts among all members of a population. The incidence of animals with empty, partially-full, and full guts also varied significantly with animal size and sampling date and implied that aspects of the amphipod's life history and seasonality were primarily responsible for changes in feeding rates. Overall, P. hoyi gut fullness was greatest in spring and, secondarily, in autumn, reflecting an opportunistic feeding strategy that exploited newly-deposited detritus generated from spring and autumn phytoplankton blooms. This strategy, in association with P. hoyi's known capacity to store energy as lipids may largely explain P. hoyi's exclusive and widespread distribution in profundal areas of the upper Great Lakes, compared to other amphipods. (Author's abstract)
W88-09552

TRACE ELEMENT CONCENTRATIONS IN NEAR-SURFACE WATERS OF THE GREAT LAKES AND METHODS OF COLLECTION, STORAGE, AND ANALYSIS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 7B.
W88-09553

RECRUITMENT OF YELLOW PERCH (PERCA FLAVESCENS) AFFECTED BY STOCK SIZE AND WATER TEMPERATURE IN LAKES ERIE AND ST. CLAIR, 1965-85,
Ontario Ministry of Natural Resources, Toronto.
B. A. Henderson, and S. J. Nepszy.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 205-215, 1988. 5 fig, 2 tab, 27 ref.

Descriptors: *Lakes, *Fish populations, *Yellow perch, *Water temperature, Temperature, Lake fisheries, Fisheries, Perch, Lake Erie, St. Clair Lake, Great Lakes.

Yellow perch populations were studied using data collected from two sources (1) samples of trawl catches (near bottom) from April to October (1965-85) in the western, central, and eastern basins of Lake Erie, and from Lake St. Clair and (2) gillnet catches from April to July in the three basins of Lake Erie (1978-86). The relative abundances of stocks in these areas were as follows: western > St. Clair > eastern > central basin. Rates of warming of water were as follows: west-

ern > St. Clair > central > eastern basin. The rates of increase in water temperature (April to June) were positively related to average water temperatures and total degree-days above 0 C. Only in the western basin of Lake Erie could the variations in recruitment to age 1+ be apportioned to the effect of parental stock size (12%) and water warming in the spring (51%). Recruitment for the young-of-the-year was explained also by both warming rate (17%) and parental stock size (12%) for the samples from the western basin. The pooled data obtained from samples of catches in the gill-nets indicated that only parental stock size (19%) determined the abundance of perch at age 1+. The relative abundance of yearlings was related to the abundance of young-of-the-year perch in the previous year in only the central and western basins (trawl sample). The dependence of recruitment on the density of the parental stock was evident from the regression of the ratio of recruits (age 1+) to spawners on parental stock size in the combined trawl samples from Lakes Erie and St. Clair, and in the separate samples from the eastern and central basins of Lake Erie and Lake St. Clair. Similarly, recruitment of the young-of-the-year was also shown to be density-dependent in all but the western basin of Lake Erie. The coefficients obtained by regressing recruitment (young-of-the-year and 1+ year) on stock size were significant and less than 1 in the pooled sample from the western basin and St. Clair, indicating density-dependent recruitment. (Casar-PTT)
W88-09554

BYTHOTREPHES CEDERSTROEMI: ITS NEW APPEARANCE IN LAKE MICHIGAN,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
M. S. Evans.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 234-240, 1988. 1 fig, 31 ref. EPA, Office of Research and Development Grant R-812311-01-1.

Descriptors: *Lakes, *Aquatic fauna, *Invertebrates, *Fish food, Lake Michigan, Lake Erie, Lake Huron, Lake Ontario, Great Lakes, Cladocerans, Sculpins, Bythotrephes cederstroemi, Growth stages.

Bythotrephes cederstroemi was newly found in Lake Michigan in September 1986. This predaceous cladoceran was previously detected in Lake Huron (December 1984) and subsequently dispersed into Lakes Ontario and Erie (autumn 1985). It was previously known only from Europe. Entry into Lake Michigan may have occurred through the exchange of Lakes Huron and Michigan water masses in the Straits of Mackinac. Bythotrephes cederstroemi was consumed by Lake Michigan deepwater sculpins in October 1986. Since bythotrephes is believed to be a surface-dwelling species, the most probable route by which it entered the sculpin diet was through the rapid sinking of dying and dead animals and their subsequent ingestion by sculpins at the sediment-water interface. Bythotrephes cederstroemi exhibited allometric and cyclomorphic growth. The caudal process was relatively straight in immature specimens and became progressively more kinked in larger (older) animals. Furthermore, the kink was more strongly developed in autumn (October) than summer (July). B. cederstroemi populations. (Author's abstract)
W88-09557

SUMMARY OF SURFACE AND BACKGROUND CONCENTRATIONS OF SELECTED ELEMENTS IN THE GREAT LAKES SEDIMENTS,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W88-09558

PRIMARY PRODUCTION AND ITS CONTROL IN TOOLIK LAKE, ALASKA,
Cincinnati Univ., OH. Dept. of Biological Sciences.
M. C. Miller, G. R. Hater, P. Spatt, P. Westlake, and D. Yeakel.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 74, No. 1, p 97-131, July 1986. 12 fig, 4 tab, 54 ref.

Descriptors: *Limiting factors, *Limnolgy, *Primary productivity, *Lakes, *Thermal stratification, *Alaska, *Phosphorus, *Nitrogen, *Phytoplankton, *Biomass, *Light penetration, Algal biomass, Toolik Lake.

Primary production of phytoplankton in Toolik Lake is low and very constant through the ice-free season from 1975-1981 averaging 14 gC/square meter/year (coefficient of variation=16%). Algal biomass increased to a maximum during the first week after ice-out in the last week of June. Particulate organic carbon, turbidity and water color were all high at the beginning of the season, decreasing in most years until late summer rainfall/runoff episodes. The lake stratified thermally in all years by early July; autumnal turnover occurred in September. Light availability limited production at most depths greater than 5 meters during the summer. In surface waters, phosphorus and nitrogen together co-limited productivity. The variance in thermal stratification controls the deep-water productivity more than variance in light or light penetration during the ice-free season. (Author's abstract)
W88-09591

EFFECTS OF ACID PRECIPITATION ON SEDIMENT DOWNCORE PROFILES OF DIATOMS, BACTERIAL DENSITIES AND SULPHUR ISOTOPE RATIOS IN LAKES NORTH OF LAKE SUPERIOR,
McMaster Univ., Hamilton (Ontario). Dept. of Chemistry.
For primary bibliographic entry see Field 5C.
W88-09592

DEVELOPMENT OF THE ROTIFER COMMUNITY STRUCTURE IN LAKE CONSTANCE DURING ITS EUTROPHICATION,
Munich Univ. (Germany, F.R.). Zoologisches Inst.
For primary bibliographic entry see Field 5C.
W88-09593

DOES THERE EXIST COMPETITION BETWEEN PHYTOPLANKTON AND LITTORAL PLANT VEGETATION IN LAKE ECOSYSTEM,
Nicholas Copernicus Univ. of Torun (Poland).
A. S. Oleksowicz.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 73, No. 4, p 575-585, March 1987. 5 fig, 2 tab, 35 ref.

Descriptors: *Competition, *Lakes, *Aquatic plants, *Phytoplankton, *Littoral zone, *Ecosystems, Chlorophyll a, Biomass, Macrophytes, Primary productivity.

Seasonal dynamics of phytoplankton was examined in several lakes with a well developed littoral zone, generally exceeding 40% of the total lake area. Peaks of chlorophyll a and plant biomass in pelagial and littoral zones were found at various periods. The first peak of phytoplankton development was observed in spring when littoral vegetation is not fully developed, and a second in autumn. During summer stratification, when development of phytoplankton in the nutrient-poor epilimnion is weaker and littoral vegetation biomass is at its highest, the maximum peaks were observed in the metalimnion and upper hypolimnion. Results of the studies show that under certain conditions, phenomena of competition for similar food forms may determine the character of development of a given group of the lake's primary producers. (Author's abstract)
W88-09594

LONGITUDINAL PROFILE OF PCO2 IN ALGAL SUSPENSION ON AN OPEN-FIELD CULTIVATION SURFACE,
Ceskoslovenska Akademie Ved, Trebon. Dept. of Hydrobotany.
K. Livansky, and J. Bartos.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 73, No. 4 p 587-598, March 1987. 5 fig, 4 tab, 19 ref.

Descriptors: *Plant growth, *Chemical equilibrium, *Carbon dioxide, *Bicarbonates, *Differential equations, *Algae, Mathematical studies, Equilibrium, Oxygen, Suspension, Cultivation.

Differential equations are derived for the course of pCO2 under conditions of CO2 formation from bicarbonate ions by chemical reactions. It is shown by computations that the replenishing of CO2 from bicarbonate is insufficient for the maintenance of exact pCO2 in chemical equilibrium. However, this difference from equilibrium is so small that it cannot be detected in experimental measurements. The pCO2 in the suspension can thus be presumed to be practically in equilibrium with bicarbonate ions. The values of pCO2 calculated for a cultivation surface 30 meters long at a partial inhibition of photosynthesis by oxygen are in good agreement experimental data. (Author's abstract)
W88-09595

INTERACTION OF CERTAIN HEAVY METALS WITH LAKE HUMIC ACIDS,
Kashmir Univ., Srinagar (India). Centre of Research for Development.
R. A. Kango, D. P. Zutshi, K. P. Dubey, and M. V. M. Desai.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 26, No. 1, p 51-59, July 1986. 6 tab, 14 ref.

Descriptors: *Chemical reactions, *Limnology, *Geochemistry, *Heavy metals, *Humic acids, *Lakes, Isotopes, Metals, Calcium, Zinc, Iron, Manganese.

Studies were carried out to investigate the interaction properties of humic acids with certain heavy metals - CA, Zn, Fe and Mn by using their isotopes. Humic acids solubilized the maximum portion of the calcium present (97% in the case of Dal Lake) with 90% present in uncomplexed form. With 59Fe, results were different with less than 30% solubilized and most of the solubilized portion in complex form. Results are presented in detail. (Author's abstract)
W88-09613

EFFECTS OF FLOODING AND SEDIMENTS ON THE STRUCTURE OF A STREAM MIDGE ASSEMBLAGE,
Ohio Univ., Athens.
J. G. Rae.
Hydrobiologia HYDRB8, Vol. 144, No. 1, p 3-10, January 9, 1987. 4 fig, 1 tab, 47 ref.

Descriptors: *Stream biota, *Floods, *Sediments, *Ecological effects, *Midges, *Aquatic insects, Aquatic populations, Streams, Ecosystems, Ecology, Population dynamics, Annual floods, Temporal distribution, Spatial distribution, Species composition, Benthic fauna, Bottom sampling, Cores, Streamflow, Population density, Resource allocation, Ohio.

Catastrophic floods are known to severely reduce the fauna in streams, but little is known of the effect of lesser floods. The major questions asked in this project were: (1) do chironomid abundances significantly change across time; (2) is there evidence that flooding controls temporal changes in abundances, and (3) does sediment structure influence assemblage structure. Sediment structure and degree of flooding were shown to affect the distribution and abundance of an assemblage of chironomid midges in a sandy bottom area of a fourth-order midwestern stream. The study area is a section of Clear Creek, located in Hocking County, in southeastern Ohio. Benthic faunal samples were collected twice a month over a period of 24 months. A sample was a sediment core 3.5 cm in diameter, with 9.6 sq cm surface area, and taken to a depth of 8 cm. A weir 1.0 km upstream provided daily values for stream flow in cubic feet per second. There was significant change in midge abundance with time, and the rate of change of

abundance was inversely related to the degree of flooding. Abundances ranged from 0.115 to 110 organisms/10 sq cm. In experimental studies of colonization of different sediments, species demonstrated strong resource partitioning; however, there was no evidence for further intraspecific partitioning of the habitat by instars. (Shidler-PTT)
W88-09619

USE OF PREDICTION TO ASSESS MACROINVERTEBRATE RESPONSE TO RIVER REGULATION,
Freshwater Biological Association, Wareham (England). River Lab.
P. D. Armitage, R. J. M. Gunn, M. T. Furse, J. F. Wright, and D. Moss.
Hydrobiologia HYDRB8, Vol. 144, No. 1, p 25-32, January 9, 1987. 1 fig, 2 tab, 43 ref.

Descriptors: *Stream biota, *Regulated flow, *Macroinvertebrates, Flow discharge, Prediction, Reservoirs, Nitrogen, Alkalinity, Chlorides, Substrates, Spatial distribution, Species composition, Species diversity, Aquatic populations, Population density, Aquatic insects, Mollusks, Oligochaetes, Environmental effects, Simulation, United Kingdom.

A technique, which uses environmental data to predict the macroinvertebrate fauna of running water sites, was used to investigate the response of faunal communities to flow regulation below a set of upland reservoirs in Great Britain. Five variables (total oxidized nitrogen, alkalinity, chloride, substratum type, and site distance from stream source) were used to predict family presence and abundance at 30 regulated sites. The predictions were compared with the observed fauna recorded in samples taken in spring, summer, and autumn. Of the 37 commonly-occurring families, 22 showed statistically significant trends. Twelve of these occurred at lower abundances than predicted and the effect was greatest in Heptageniidae, Simuliidae, Elminthidae, Perlodidae, and Rhyacophilidae. Ten families were more abundant than predicted and these included Polycentropodidae, Sphaeriidae, Sialidae, and some groups of chironomids and oligochaetes. Fifteen families showed no significant trends. Most families showed little difference in the observed and expected frequency of occurrence in the 30 sites but Taeniopterygidae and Perlidae, among others, occurred at less than the expected number of sites and Hydridae, Prodiamesinae, and Muscidae occurred more commonly than expected. These faunal responses are discussed in relation to environmental changes arising from flow regulation. The possible uses of the predictive technique in simulating and assessing the effects of regulation on downstream fauna are outlined. (Author's abstract)
W88-09621

EFFECTS OF EXPERIMENTAL ACIDIFICATION ON A LOTIC MACROINVERTEBRATE COMMUNITY,
Laval Univ., Quebec. Dept. de Biologie.
For primary bibliographic entry see Field 5C.
W88-09622

CONSEQUENCES OF REDOX CONDITIONS ON THE DISTRIBUTION OF CATIONS IN A MEROMICTIC OLIGOTROPHIC LAKE,
Clermont-Ferrand-2 Univ., Aubiere (France).
F. Restituito.
Hydrobiologia HYDRB8, Vol. 144, No. 1, p 63-75, January 9, 1987. 9 fig, 7 tab, 19 ref.

Descriptors: *Lakes, *Oxidation-reduction potential, *Cations, *Meromictic lakes, *Oligotrophic lakes, *Limnology, Cations, Chemical properties, Temporal distribution, Lake Pavin, France, Craters, Calcium, Magnesium, Zinc, Sodium, Potassium, Manganese, Iron, Mixolimnion, Monimolimnion, Epilimnion, Sediments, Chemocline, Meromixis.

Lake Pavin occupies a volcanic crater, situated at a height of 1197 meters; its maximum depth is 96 m. The cations Ca, Mg, Zn, Na, K, Mn, and Fe were measured during the year 1977 in the mixolimnion and in the monimolimnion of the lake. The study was principally based on the analysis of the epilimnion sediment and on the variations in the concentration of the principal cations. The great difference between the residence time for Ca, Mg, Na, and K (15 years) and for Mn and Fe (> 90 years) is due to the redox reactions in the chemocline. The overturn conditions and their influence on cation accumulations were also studied: the spring overturn affects the water column down to 60 or 70 m depending on the year; the autumn overturn is much less intense. (Shidler-PTT)
W88-09623

CHANGES IN THE PHYSICAL AND CHEMICAL PROPERTIES OF FLOODWATER AND SEDIMENT IN AN EXPERIMENTAL RICE-FIELD (REGGIO EMILIA, ITALY),
Parma Univ. (Italy). Ist. di Ecologia.
R. Antonietti, P. Viaroli, and F. Antonietti.
Hydrobiologia HYDRB8, Vol. 144, No. 1, p 83-88, January 9, 1987. 6 fig, 19 ref.

Descriptors: *Limnology, *Wetlands, *Sediments, *Suspended sediments, *Floodwater, *Rice, Italy, Aquatic environment, Particulate matter, Organic matter, Physical properties, Chemical properties, Temporal distribution, Spatial distribution, Water temperature, Opacity, Dissolved oxygen, Proteins, Chlorophyll a, Phosphorus, Oxidation-reduction potential, Hydrogen ion concentration, Production, Respiration, Sediment-water interfaces, Particle size.

The role of biological processes occurring in the water/sediment interface in the controlling of physical and chemical properties of ricefield ecosystems has been described by many authors, but the role of particulate suspended matter is not yet as well defined as for other environments. The aims of this research were both to verify the influence of particulate organic matter in defining the physical and chemical properties of the floodwater and to gather information on the particulate organic matter composition. Changes in time and space in the physical and chemical variables connected to the oxygen production/respiration ratio were studied. Temperature, light transmission, dissolved oxygen (and its day-night cycles) were measured periodically in the floodwater; in addition, concentrations of total phosphorus, proteins and chlorophyll-a in the particulate suspended matter were measured. Finally, the seasonal evolution of the redox conditions in the water and in the sediment were analyzed. Highly significant correlations between pH and DO in the water, and oxygen production were found; the pH and Eh values of the water/sediment interface were strictly related to the corresponding values reached in the water. The composition and the size of the particulate suspended matter pool seemed to be relatively stable and unrelated to the physical and chemical characteristics of the water. (Shidler-PTT)
W88-09624

INVESTIGATION OF A TOXIC WATER-BLOOM OF MICROCYSTIS AERUGINOSA (CYANOPHYCEAE) IN LAKE AKERSVATN, NORWAY,
Norges Veterinaerhoegskole, Oslo. Dept. of Food Hygiene.
For primary bibliographic entry see Field 5C.
W88-09625

AQUATIC OLIGOCHAETA IN SOME TRIBUTARIES OF THE RIO DE LA PLATA, BUENOS AIRES, ARGENTINA,
Universidad Nacional de La Plata (Argentina). Inst. de Embriologia.
For primary bibliographic entry see Field 5C.
W88-09626

PRIMARY PRODUCTION AND PIGMENTS IN THREE LOW ALKALINITY CONNECTED RESERVOIRS RECEIVING MINE WASTES,
Instituto Nacional de Investigacao des Pescas, Lisbon (Portugal).
For primary bibliographic entry see Field 5C.
W88-09627

REGULATION OF BLUE-GREEN ALGAL BUOYANCY AND BLOOM FORMATION BY LIGHT, INORGANIC NITROGEN, CO2, AND TROPHIC LEVEL INTERACTIONS,
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
C. N. Spencer, and D. L. King.
Hydrobiologia HYDRB8, Vol. 144, No. 2, p 183-192, January 20, 1987. 1 fig, 2 tab, 51 ref.

Descriptors: *Limnology, *Algae, *Cyanophyta, *Buoyancy, *Eutrophication, *Light intensity, *Trophic Level, Nitrogen, Carbon dioxide, Ponds, Chemical properties, Physical properties, Biological properties, Waterfleas, Diatoms, Chlorophyta, Zooplankton, Fish, Fish food organisms.

In highly eutrophic ponds, buoyancy of the gas-vacuolate blue-green alga Anabaenopsis elenkinii was regulated by complex interactions between chemical and physical parameters, as well as by biological interactions between various trophic levels. Algal buoyancy and surface bloom formation were enhanced markedly by decreased light intensity, and to a lesser extent by decreased carbon dioxide availability and increased availability of inorganic nitrogen. In the absence of dense populations of large-bodied cladocera, early season blooms of diatoms and green algae reduced light availability in the ponds thus creating conditions favorable for increased buoyancy and bloom formation by A. elenkinii. The appearance of blue-green algal blooms could be prevented by a reduced density of planktivorous fish, which allowed development of dense cladoceran populations. The cladocerans limited the growth of precursory blooms of diatoms and green algae, and give the resulting clear-water conditions, buoyancy of A. elenkinii was reduced, and blue-green algal blooms never appeared. (Author's abstract)
W88-09628

EVALUATION OF MICROCYSTIS AS FOOD FOR ZOOPLANKTON IN A EUTROPHIC LAKE,
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
T. Hanazato, and M. Yasuno.
Hydrobiologia HYDRB8, Vol. 144, No. 3, p 251-259, January 30, 1987. 5 fig, 6 tab, 24 ref.

Descriptors: *Limnolgoy, *Algae, *Microcystis, *Food habits, *Zooplankton, *Eutrophic lakes, Waterfleas, Biomass, Productivity, Animal growth, Population dynamics, Chlorella, Decomposition, Inhibitors, Japan, Lakes.

In shallow and highly eutrophic Lake Kasumigaura the biomass and production of cladoceran zooplankton reach the highest level in the summer, when Microcystis aeruginosa forms a heavy water bloom. Four experiments were conducted to evaluate Microcystis as food for zooplankton in Lake Kasumigaura, and the following results were obtained: (1) Moina micrura (Cladocera) showed little growth and no reproduction when the animal was reared with Microcystis cultured in the laboratory; the animal did not grow nor reproduce well when Chlorella was mixed with Microcystis as food. (2) Moina micrura assimilated Microcystis much less than Chlorella when the animal fed on single species of Microcystis or a mixture with Chlorella. (3) Microcystis collected from Lake Kasumigaura could not be utilized by Moina micrura even though the colonies were broken up into edible sizes; however, the alga turned into utilizable food when it was decomposed. (4) No inhibitors of Moina micrura population growth could be found in the non-filtered water of Lake Kasumigaura where Microcystis was blooming heavily. Decomposed Microcystis seemed to be utilized by zooplankton as an important food source in Lake Kasumigaura. (Shidler-PTT)
W88-09631

MACROINVERTEBRATE DRIFT IN A ROCKY MOUNTAIN STREAM,
Maryland Univ., College Park. Dept. of Zoology.
J. D. Allan.
Hydrobiologia HYDRB8, Vol. 144, No. 3, p 261-

268, January 30, 1987. 7 fig, 2 tab, 22 ref. NSF Grants DEB 7503396 and DEB 7711131.

Descriptors: *Stream biota, *Macroinvertebrates, *Aquatic drift, *Alpine regions, Rocky Mountains, Species composition, Population density, Sampling, Diurnal distribution, Seasonal distribution, Regression analysis, Correlation analysis, Prediction, Benthos, Insects, Mayflies, Stoneflies, Caddisflies, Stream discharge, Water temperature, Streams.

An extensive series of drift collections from a Rocky Mountain stream was used to investigate quantitative patterns in the taxonomic composition of drift throughout spring, summer and fall for 1975-1978. Drift was estimated by drift rate, the number of organisms drifting past a point per 24 h; and by drift density, the numbers of organisms collected per 100 cubic m of water sampled. Drift densities were up to ten times greater by night than by day, and 24 h drift densities for the total fauna approached 2000 per 100 cubic m in June-July, declining to < 500 by autumn. Ephemeroptera, and especially Baetis, dominated the drift. Drift rates were greatest in late spring, around 1,000,000 per 24 h, which are among the highest values reported for small trout streams. Drift rates declined to < 100,000 during the summer, and shifts in the taxonomic composition are described. Multiple-regression analysis of the relationship between drift rate and density, and the independent variables discharge, benthic density, and temperature showed that discharge typically was a significant predictor of 24 h drift rate, usually the best single predictor. In contrast, 24 h drift density most frequently was independent of discharge, indicating that this measure tends to correct for seasonal variation in discharge, as suggested in the literature. However, this was not invariably true. Drift density significantly correlated with benthic density in five of eight taxa inspected, thus seasonal declines in the benthos probably accounted for parallel declines in drift density. (Author's abstract)
W88-09632

LIFE HISTORY, PRODUCTION AND FOOD HABITS OF PONTOPOREIA AFFINIS LINDSTROM (CRUSTACEA: AMPHIPODA) IN MESOTROPHIC LAKE ERKEN,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
R. K. Johnson.
Hydrobiologia HYDRB8, Vol. 144, No. 3, p 277-283, January 30, 1987. 4 fig, 1 tab, 24 ref.

Descriptors: *Lentic environment, *Life history studies, *Productivity, *Food habits, *Crustaceans, *Amphipods, *Mesotrophic lakes, Benthos, Lipids, Lakes, Aquatic animals, Population density, Dynamics, Europe, Sweden, Sediment sampler, Phytoplankton, Water sampling, Biomass, Water depth, Life cycles, Population dynamics, Animal growth, Detritus, Algae, Seasonal distribution, Diatoms, Eutrophication.

Pontoporeia affinis Lindstrom is a glacial relict amphipod which often predominates the profundal benthos of lentic systems of the glaciated regions of Europe. The amphipods' high lipid content (e.g., 33.1% dry weight) and high population densities suggest that Pontoporeia may play an important role in profundal trophic dynamics. The life history and feeding habits of Pontoporeia affinis were studied in mesotrophic Lake Erken, Sweden, during 1982 to 1983. Bottom samples were collected from 8, 10, 12, 14, 16, 18, and 20 m depths in the profundal region of the lake, using an Ekman sampler; phytoplankton counts and biovolume enumerations were made on water samples collected from 1 m depth using a 2.7 l Ruttner sampler. The greatest densities and biomasses of P. affinis occurred at 12 m (662 individuals/square m and 118.2 mg dry weight/square m, respectively) with values decreasing at the shallower and deeper regions. The life cycle of Pontoporeia was one year, with recruitment occurring in April, at which time the majority of the population consisted of individuals < 2 mm. Overall the gut content of Pontoporeia was predominantly composed of detritus (97.6%) with algae accounting for 2.3%. Annual production was highest at 12 m (386.2 mg dw/square m) and lowest at 16 m (8.1). The highest production occurred during September, coinciding with the autumn Bacillariophyceae bloom. (Shidler-PTT)
W88-09633

DILUTION BIOASSAYS: THEIR APPLICATION TO ASSESSMENTS OF NUTRIENT LIMITATION IN HYPEREUTROPHIC WATERS,
North Carolina Univ., Morehead City. Inst. of Marine Sciences.
For primary bibliographic entry see Field 7B.
W88-09634

EFFECT OF SALMON REDD EXCAVATION ON STREAM SUBSTRATE AND BENTHIC COMMUNITY OF TWO SALMON SPAWNING STREAMS IN CANTERBURY, NEW ZEALAND,
Ministry of Agriculture and Fisheries, Christchurch (New Zealand). Fisheries Research Div.
M. S. Field-Dodgson.
Hydrobiologia HYDRB8, Vol. 15, p 3-11, November 16, 1987. 6 fig, 2 tab, 20 ref.

Descriptors: *Stream biota, *Salmon, *Nesting, *Streambeds, *Benthic fauna, *Spawning, New Zealand, Invertebrates, Detritus, Riffles, Standing crops, Ecological effects, River beds, Benthos.

The effects of nest, or redd, excavation by female quinnat salmon (Oncorhynchus tshawytscha Walbaum) on the benthic invertebrate communities of two stable springfed spawning streams in the headwaters of the Rakaia River, South Island, New Zealand, were studied during January to September 1982). The gross effects of salmon spawning on the streams appear to be: the loss of instream macrophytes, algae, and mosses; a loss of fines and detritus; and a modification of the pool-riffle character. Redd excavation may be associated with a reduction in benthic standing crop of up to 83.6%, with only a minor effect on the benthic community structure. Benthic recolonization rates were similar for both spawning streams, with almost complete recovery after 95 days. (Author's abstract)
W88-09635

EFFECTS OF PHYSICAL DISTURBANCE AND CANOPY COVER ON ATTACHED DIATOM COMMUNITY STRUCTURE IN AN IDAHO STREAM,
Idaho State Univ., Pocatello. Dept. of Biological Sciences.
C. T. Robinson, and S. R. Rushforth.
Hydrobiologia HYDRB8, Vol. 154, p 49-59, November 16, 1987. 4 fig, 2 tab, 37 ref.

Descriptors: *Stream biota, *Diatoms, *Ecological effects, *Canopy, *Aquatic plants, Epiphytes, Chrysophyta, Ecosystems, Streams, Substrates, Idaho, Species diversity, Amphora, Navicula, Cocconeis, Achnanthes, Light intensity, Morphology.

A field experiment was conducted to determine the effect of disturbance frequency on diatom communities established on artificial substrates within an open-canopy and a closed-canopy site of a third-order stream. The open-canopy site (OCS) had a total of 80 diatom taxa colonizing the substrates, while the closed-canopy site (CCS) had only 55 taxa. Cluster analysis revealed that the two sites had distinct diatom communities, although the most common species were similar between sites. There was no effect of disturbance frequency on species diversity at OCS; however, species diversity significantly decreased as disturbance frequency increased at CCS. At OCS, Amphora perpusilla increased in abundance as disturbance frequency increased, while Navicula lanceolata abundance decreased as disturbance increased. At CCS, Cocconeis placentula v. euglypta remained dominant regardless of disturbance frequency. The results suggest that some diatom species may be 'shade adapted', which may explain the site-specific responses. In addition, diatom growth-forms may explain the within-site taxon-specific responses to disturbance. For example, Achnanthes sp. and Cocconeis sp., small horizontal forms, were predominant on the high-disturbance substrates. Vertical or large horizontal forms may be mechanically removed by frequent physical disturbance allowing such small horizontal forms to become abundant. Frequent disturbance, by maintaining the community in an early stage of development, directly influences the diatom assemblages on rocks in streams. (Author's abstract)
W88-09637

CONTRIBUTION FROM NITROGEN FIXATION (ACETYLENE REDUCTION) TO THE NITROGEN BUDGET OF LAKE TOHOPEKALIGA (FLORIDA),
Florida Inst. of Tech., Melbourne. Dept. of Environmental Sciences and Engineering.
F. E. Dierberg, and M. M. Scheinkman.
Hydrobiologia HYDRB8, Vol. 154, p 61-73, November 16, 1987. 4 fig, 6 tab, 39 ref.

Descriptors: *Limnology, *Lakes, *Nitrogen fixation, *Acetylene Reduction, *Nitrogen cycle, Nitrogen, Diurnal distribution, Seasonal distribution, Algae, Anabaena, Florida, Wastewater disposal, Nutrients, Cycling nutrients, Water sampling, Sediment sampler, Chromatography.

Major point sources of nutrients to Lake Tohopekaliga, a 8120-hectare lake belonging to the Upper Kissimmee Chain of Lakes in central Florida, are two wastewater treatment plants with combined flows of 25,000,000 gallons per day. Questions on the nutrient dynamics of have been raised based on the spatial distribution of total phosphorus, total nitrogen, inorganic nitrogen, and chlorophyll a. The two objectives in this investigation were: (i) to compare the annual average acetylene reduction activity among seven lake stations for both the water column and sediment and (ii) to determine what percentage of the total N input is contributed by nitrogen fixation. At each station serum bottles were filled to two-thirds capacity with surface water. For the sediment samples, a Ponar dredge was used to collect surface sediment (2-10 cm deep, depending on the station location); then 25 ml of sediment slurry was inserted into serum bottles. Two-thirds of the samples were injected with acetylene; the remainder served as controls for natural biological ethylene production. After incubation, the samples were chromatographically analyzed for ethylene. Nitrogen fixation, as assayed by the acetylene reduction technique, provided 44% of the input of nitrogen to the lake during 1984. Ninety-four percent of the lake total fixation was found in the water column and associated with Anabaena spp. The lake-wide average nitrogen fixation rate of 5.7 g N/square m/yr amounted to a mass loading of 497 metric tons of nitrogen for the year, and is one of the highest nitrogen fixation rates reported. (Shidler-PTT)
W88-09638

VERTICAL TRANSPORT AND ITS EFFECTS ON EPILIMNETIC PHOSPHORUS IN FOUR CALCAREOUS LAKES,
Wisconsin Univ.-Madison. Water Chemistry Lab.
For primary bibliographic entry see Field 5B.
W88-09639

MICRONUTRIENT AND PHOSPHORUS LIMITATION OF PHYTOPLANKTON ABUNDANCE IN GEM LAKE, SIERRA NEVADA, CALIFORNIA,
California Univ., Santa Barbara. Dept. of Biological Sciences.
J. L. Stoddard.
Hydrobiologia HYDRB8, Vol. 154, p 103-111, November 16, 1987. 6 fig, 3 tab, 44 ref. Water Resources Center, Davis, CA, Grant UCAL-WRC-W-619.

Descriptors: *Limnolgoy, *Aquatic plants, *Iron, *Copper, *Phosphorus, *Nutrient requirements, *Phytoplankton, *Mountain lakes, Sierra Nevada, California, Algae, Chlorophyll, Carbon, Nitrogen, Plant growth, Biomass, Lentic environment, Chemical properties, Plant populations, Nutrients.

Nutrient-addition experiments conducted during the ice-free seasons of 1983 and 1984 in Gem Lake,

an alpine lake in the Sierra Nevada mountains of California, indicate that algal biomass is limited by phosphorus, in combination with iron or copper. Phosphorus additions were always required to stimulate growth, but did not do so when phosphorus was the only nutrient added. Simultaneous additions of phosphorus and iron resulted in increased levels of chlorophyll, particulate carbon, particulate nitrogen, and particulate phosphorus. Simultaneous additions of phosphorus and copper resulted in increases in chlorophyll, particulate nitrogen, and particulate phosphorus, but not in particulate carbon. Neither iron nor copper by itself stimulated growth. Particulate N:P ratios from all seasons in Gem Lake suggest that simultaneous micronutrient and phosphorus limitation exists throughout the summer, when nutrient and biomass levels remain low; limitation by phosphorus alone may appear in the fall and spring, when biomass and major-ion concentrations increase dramatically. (Author's abstract)
W88-09640

PARTICULATE ORGANIC MATTER IN A MOUNTAIN STREAM IN THE SOUTH-WESTERN CAPE, SOUTH AFRICA,
Cape Town Univ. (South Africa). Dept. of Zoology.
For primary bibliographic entry see Field 2E.
W88-09642

MODELLING THE EFFECT OF ACIDITY ON MERCURY UPTAKE BY WALLEYE IN ACIDIC AND CIRCUMNEUTRAL LAKES,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 5B.
W88-09660

DISTRIBUTION OF FRESHWATER SNAILS IN THE RIVER NIGER BASIN IN MALI WITH SPECIAL REFERENCE TO THE INTERMEDIATE HOSTS OF SCHISTOSOMES,
Danish Bilharziasis Lab., Charlottenlund.
For primary bibliographic entry see Field 5B.
W88-09670

PROTOZOAN COMMUNITIES OF THE FLINT RIVER - LAKE BLACKSHEAR ECOSYSTEM (GEORGIA, USA),
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
J. R. Pratt, R. Horiwtz, and J. Cairns.
Hydrobiologia HYDRB8, Vol. 148, No. 2, p 159-174, May 20, 1987. 9 fig, 6 tab, 47 ref.

Descriptors: *Stream biota, *Aquatic animals, *Water pollution effects, *Bioindicators, *Protozoa, *Lakes, *Species composition, *Species diversity, Animal populations, Environmental gradient, Hardness, Nutrients, Substrates, Ecosystems, Georgia.

Freshwater protozoa are poorly characterized in river ecosystems. We report here the richness of the protozoan biotas in relation to environmental gradients from an ecosystematic survey of a large, coastal plain river. Communities were collected from natural and artificial substrates concurrent with water chemistry analysis at 11 sites along the Flint River and Lake Blackshear impoundment. Community similarity, the distribution of collected taxa in functional feeding groups, and the relation of communities to environmental gradients were evaluated. Two principal components determined from water chemistry data showed important downstream gradients of decreasing water hardness and increasing nutrient levels. Taxonomic richness was high: 200 to 450 taxa were collected depending on season and collecting technique. Artificial substrates provided the richest collections. Bactivorous species were the vast majority of all taxa collected. Community composition showed an orderly transition from upstream to downstream, and photosynthetic forms were enhanced at nutrient enriched sites. Communities were strongly influenced by increasing nutrient levels. Protozoan community analysis showed that microbial community composition reflects human influences on river ecosystems. Since microbial species exploit detrital resources and respond sensitively to human influences, they can provide important information regarding ecosystem conditions. (Author's abstract)
W88-09675

ROLE OF GROUNDWATER IN THE IMPACT OF CLIMATE WARMING ON STREAM SALMONINES,
Toronto Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 2F.
W88-09677

SUCCESSION IN ZOOPLANKTON AND HYDROPHYTES OF A SEASONAL WATER ON THE WEST COAST OF SOUTH AFRICA,
Department of Nature and Environmental Conservation, Stellenbosch (South Africa).
A. H. Coetzer.
Hydrobiologia HYDRB8, Vol. 148, No. 3, p 193-210, May 30, 1987. 8 fig, 1 tab, 54 ref.

Descriptors: *Lakes, *Eutrophication, *Succession, *Zooplankton, *Hydrophytes, *Seasonal water, *Brackish water, *Shallow water, *Seasonal variation, *Estuarine environment, South Africa, Phytoplankton, Water depth, Turbidity, Suspended solids, Eutrophication.

Certain aspects of the biotic components of a seasonal water (Rocher Pan), subject to large seasonal fluctuations in physical and chemical features, were investigated in 1981/82. Phytoplankton development and succession were largely dependent on water-depth and turbidity. Observed increases in marginal hydrophyte stands and suspended solid loads of the water were related to eutrophication. Factors which influenced the functioning of the aquatic ecosystem were identified as water-depth, turbidity, orthophosphates, chlorides, conductivity and total dissolved solids (TDS) Diatom species were more abundant during the early and later months when the pan was inundated, and the values of chloride, conductivity and TDS were relatively high. The succession of primary consumers was related to food resources and habitat requirements. From the overall results it is evident that the preservation of a water body that is subject to human influences or accelerated natural processes, should involve active management actions to provide a balance between nutrient input and export for the maintenance of the status quo. (Author's abstract)
W88-09678

EFFECTS OF LAND USE UPON WATER CHEMISTRY, PARTICULARLY NUTRIENT ENRICHMENT, IN SHALLOW LOWLAND LAKES: COMPARATIVE STUDIES OF THREE LOCHS IN SCOTLAND,
Dundee Univ. (Scotland). Dept. of Biological Sciences.
For primary bibliographic entry see Field 4C.
W88-09679

SEASONAL GROWTH OF THE SUBMERGED MACROPHYTE CERATOPHYLLUM DEMERSUM L. IN MESOTROPHIC LAKE VECHTEN IN RELATION TO INSOLATION, TEMPERATURE AND RESERVE CARBOHYDRATES,
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
E. P. H. Best, and H. W. C. Visser.
Hydrobiologia HYDRB8, Vol. 148, No. 3, p 231-243, May 30, 1987. 4 fig, 4 tab, 28 ref.

Descriptors: *Plant growth, *Lakes, *Mesotrophic lakes, *Solar radiation, *Temperature effects, Carbohydrates, *Macrophytes, *Aquatic productivity, *Ceratophyllum, Starch, Sugars, Thermal stress, Netherlands, Growth rates, Seasonal variation, Biomass.

Seasonal growth of a Ceratophyllum demersum stand in Lake Vechten, The Netherlands, varied considerably during 1978, '79 and '81. The biomass was highest in 1981 (max. 115 g ash-free dry weight/sq m). The 1978 growth trend was similar to that of 1981 with slightly lower net annual production (max. 92 g AFDW/sq m). The vegetation almost disappeared in 1979 (max. 24 g AFDW/sq m). These large differences in biomass could not be explained by differences in insolation but were mainly attributed to the severe winter of 1978-79 which slowed plant development and full maturity was attained only after the diurnal insolation had decreased. Reserve carbohydrates were primarily starch and water-soluble sugars. Starch concentrations varied between 71.5 and 24.7 mg/g AFDW in the winter and summer, and total sugar concentrations between 24.9 and 20.2 mg/g AFDW, respectively. The non-reducing sugars tended to predominate in summer and the reducing sugars in winter. The value of these reserves for maintenance, growth and survival was assessed by calculating plant carbon budgets for several seasons. It was concluded that C. demersum relies heavily on its developmental timing and energy-conserving physiological mechanisms to survive extended periods of stress and in these respects is analogous to a typical terrestrial shade plant. (Author's abstract)
W88-09680

LONGITUDINAL DISTRIBUTION OF RIVERINE BENTHOS: A RIVER DIS-CONTINUUM,
Minnesota Univ., St. Paul. Dept. of Forest Resources.
J. A. Perry, and D. J. Schaeffer.
Hydrobiologia HYDRB8, Vol. 148, No. 3, p 257-268, 1987. 3 fig, 4 tab, 34 ref. Project MN-42-25 of the McIntire-Stennis Cooperative Forestry Research Program and the USDA.

Descriptors: *Spatial distribution, *Stream gradient, *Stream profiles, *Stream biota, River beds, Species distribution, Statistical analysis.

We used several techniques to analyze 10-11 collections from each of 13 stations along a mountain stream gradient to examine the hypothesis that there was a statistically significant ($p < 0.05$) uniform downstream gradient in benthic distribution. Random skewer techniques suggested that there was a significant downstream gradient of individuals per species, but only a weak gradient in species per station, and no gradient in functional guild composition. Ordination and clustering of either taxonomic or functional guild data suggested the existence of four longitudinally defined groups of stations. Rarefaction curves also implied longitudinal groupings, with differences among groups implying species replacement rather than changes in organism numbers. Two species replacement indexes confirmed that suggestion. In summary, the distribution of the benthos in the creek may best be characterized as a punctuated gradient where gradual downstream changes in community composition are punctuated by sudden shifts to new community types. This punctuated gradient appears caused by changes in stream physical and chemical characteristics; the rapid nature of the changes hampers the interpretation of longitudinal analyses. Techniques such as random skewers and cluster analysis of rarefied samples will prove helpful in discerning pattern in stream benthos. (Author's abstract)
W88-09681

INFLUENCE OF AGRICULTURAL PRACTICES ON THE BIOCOENOTIC STRUCTURE OF LIMNETIC PHYTOPLANKTON (INFLUENCE DES TRAITEMENTS PHYTOSANITAIRES SUR LES BIOCOENOSES DU PHYTOPLANCTON LIMNIQUE),
Paris-11 Univ., Orsay (France). Lab. de Zoologie et d'Ecologie.
For primary bibliographic entry see Field 5C.
W88-09682

EFFECT OF RAINSTORMS ON HETEROTROPHIC BACTERIAL ACTIVITY IN A HYPERTROPHIC AFRICAN LAKE,
National Inst. for Water Research, Pretoria (South Africa).
R. D. Robarts.
Hydrobiologia HYDRB8, Vol. 148, No. 3, p 281-

286, May 30, 1987. 4 fig, 1 tab, 8 ref.

Descriptors: *Water pollution effects, *Eutrophication, *Turbidity, *Lakes, *Reservoir silting, *Heterotrophic bacteria, *Bacteria, *Influent water, Population density, Population dynamics, Vertical distribution, Glucose, Metabolism, Density currents, Artificial lakes.

Hartbeespoort Dam is a man-made lake which is located in the Transvaal Province of South Africa; it is hypertrophic due to the inflow of treates sewage effluents . This region has recently experienced its most severe drought of the century. However, on three occasions in the summer rainy seasons of 1984 and 1985, major rainfalls (> 50 mm) occurred which caused large inflows to the lake. Inflowing river water entered as a density current causing marked silting of the water. Within the epilimnion (0-10 m) prior to these rainfalls there was usually no variation of bacterial numbers with depth, but heterotrophic bacterial activity (glucose uptake) decreased with depth concomitant with primary production. With the increased river inflow bacterial numbers did not increase but bacterial activity at the bottom of the epilimnion (10 m) increased to as high as 2.7 micrograms C/L/h in January 1985, reversing the depth profile of bacterial activity within the epilimnion. This resulted in decreased glucose concentrations and turnover times. Heterotrophic activity per cell increased by between 2.5 and 5 times. These data demonstrate that storm events are important phenomena causing short-term changes in the metabolic activity of planktonic heterotrophic bacteria in lakes. (Author's abstract)
W88-09683

NUTRIENT RESPONSES TO THE LIMING OF LAKE GARDSJON,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 5G.
W88-09684

MACROINVERTEBRATE ASSEMBLAGES IN PENNSYLVANIA (U.S.A.) SPRINGS,
Juniata Coll., Huntingdon, PA. Dept. of Biology.
D. S. Glazier, and J. L. Gooch.
Hydrobiologia HYDRB8, Vol. 150, No. 1, p 33-43, May 30, 1987. 5 fig, 4 tab, 35 ref. NSF Research in Undergraduate Institutions Grant BSR 8406400.

Descriptors: *Macroinvertebrates, *Aquatic populations, *Springs, *Species composition, *Amphipods, *Aquatic insects, Spring water, Population density, Cluster analysis, Mathematical analysis, Pennsylvania.

Five distinct macroinvertebrate assemblages were identified using cluster analysis of the rank-order abundances of 13 orders in 15 freshwater springs of central Pennsylvania, U.S.A. A principal components analysis of 20 environmental factors indicated that an insect-dominated assemblage occurred in low pH, softwater sandstone springs and an amphipod-dominated assemblage was associated with medium to hardwater springs with a silt to gravel substratum. Three other assemblages were found in hardwater limestone springs: the peracaridan-hydrobiid assemblage was characterized by dense macrophyte beds and a silt to cobble substratum, the peracaridan-triclad-glossosomatid assemblage by a rubbly gravel-cobble substratum and relatively high discharge, and the peracaridan-hydrobiid-oligochaete assemblage by a silty substratum and dense mats of green algae. Most of the common macroinvertebrate species were associated with specific physical, chemical, and (or) vegetational factors, but abundance associations between species pairs were generally lacking. We infer that assemblages are primarily determined by the match between the environmental mosaic of individual springs and the ecological requirements of the available species, rather than by strong interspecific interactions. Species-environment associations were assessed in an additional study of five closely neighboring springs in which some environmental variables of the wider study were nearly constant. (Author's abstract)
W88-09685

MACRO-INVERTEBRATE COMMUNITIES OF TEMPORARY POOLS IN AN INTERMITTENT STREAM IN TROPICAL QUEENSLAND,
James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Zoology.
R. E. W. Smith, and R. G. Pearson.
Hydrobiologia HYDRB8, Vol. 150, No. 1, p 45-61, May 30, 1987. 12 fig, 5 tab, 27 ref.

Descriptors: *Aquatic populations, *Macroinvertebrates, *Intermittent streams, *Intermittent lakes, *Species diversity, *Species composition, *Temporary pools, Mathematical analysis, Australia, Cluster analysis, Population density, Principal component analysis, Seasonal variation.

Nine pools were studied in an intermittent stream. They were close to each other but differed in size, substratum, amount of shade and duration of water presence. Initial conditions were set by wet season flooding, following which each pool developed its own character. Cluster analysis showed that communities changed substantially with time in both species composition and abundance, and that some initially similar communities diverged while some initially dissimilar ones converged. Principal Components Analysis showed that these community changes were due largely to the drying of the pools, and to seasonal effects. Specialized drying communities developed in the pools of longer duration (up to 8 months), but not in the short-lived pools (3-4 months). Apparently similar numerical responses in different pools were often caused by different suites of predominant species. The diversity of the fauna (total of 78 species) was high in comparison with similar habitats in non-tropical regions. The pattern of development of the pools' communities was much as expected from island biogeography theory, except that there was no relationship between species richness and duration and size of pools. The species complements were largely opportunistic, being governed by extreme environmental disturbance. (Author's abstract)
W88-09686

MACROZOOBENTHOS OF THREE PENNSYLVANIA LAKES: RESPONSES TO ACIDIFICATION,
Lehigh Univ., Bethlehem, PA. Center for Marine and Environmental Studies.
For primary bibliographic entry see Field 5C.
W88-09687

POSSIBLE CAUSES OF HIGH SPECIES DIVERSITY IN TROPICAL AUSTRALIAN FRESHWATER MACROBENTHIC COMMUNITIES,
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
P. M. Outridge.
Hydrobiologia HYDRB8, Vol. 150, No. 2, p 95-107, July 20, 1987. 1 fig, 2 tab, 40 ref.

Descriptors: *Species diversity, *Lakes, *Limnology, *Tropical regions, *Macroinvertebrates, *Benthic fauna, *Streams, Aquatic animals, Lagoons, Riffles, Stream biota, Lentic environment, Australia.

A total of 133 benthic macroinvertebrate species was recorded in four permanent freshwater lagoons (billabongs) and a stream riffle in the Magela Creek catchment, Northern Territory, Australia. 101 species were lentic in occurrence. Each billabong supported at least as many species as larger tropical and Australian temperate lakes, and was an exception to the species-poor status of Australian lentic macrobenthic communities. Greater than 98% of the total benthic biomass was contributed by a mussel species; the remaining species combined standing crop was an order of magnitude lower than in other lentic systems, further highlighting the diversity of the Magela benthos. Rarefaction (removal of organisms) and predictable environmental heterogeneity, both related to monsoonal variations in flow and water quality, were probably important determinants of the high diversity of these communities. (Author's abstract)
W88-09688

EXAMINATION OF ASSOCIATION INDICES AND FORMULATION OF A COMPOSITE SEASONAL DISSIMILARITY INDEX,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Fisheries Research Branch.
For primary bibliographic entry see Field 7C.
W88-09689

INFLUENCES OF HABITAT AND SEASONAL SAMPLING REGIMES ON THE ORDINATION AND CLASSIFICATION OF MACROINVERTEBRATE ASSEMBLAGES IN THE CATCHMENT OF THE RIVER WYE, WALES,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 7C.
W88-09690

FLOATING VEGETATION MATS ON A FLOODPLAIN BILLABONG IN THE NORTHERN TERRITORY IN AUSTRALIA,
New South Wales Univ., Kensington (Australia).
R. Hill, G. J. W. Webb, and A. M. A. Smith.
Hydrobiologia HYDRB8, Vol. 150, No. 2, p 153-164, July 20, 1987.

Descriptors: *Lakes, *Limnology, *Floating plants, *Flood plains, *Billabongs, *Rivers, *Aquatic flora, *Insect behavior, *Drought, Plant populations, Population dynamics, Water buffalo, Australia.

The floristics and physical structure of a floating mat of vegetation in the Finniss River area of the Northern Territory are described. During the dry season, floating mats contain green productive vegetation when the adjacent flood plains are dry and many of the plants are withered. At this time insects are more abundant on the mats than on the adjacent flood plain. Some flood plain vertebrates appear to concentrate their activity on floating mats during the dry season. During the period 1963 to 1978 the area of floating mat in the Finniss River study area was greatly reduced, probably as a result of high densities of feral water buffalo (Bubalis bubalus). (Author's abstract)
W88-09691

SEASONALITY OF MONSOONAL PRIMARY PRODUCTIVITY IN SRI LANKA,
Calgary Univ. (Alberta). Aquatic Ecology Section.
E. I. L. Silva, and R. W. Davies.
Hydrobiologia HYDRB8, Vol. 150, No. 2, p 165-175, July 20, 1987. 7 fig, 4 tab, 34 ref.

Descriptors: *Limnology, *Primary productivity, *Seasonal variation, *Phytoplankton, *Aquatic productivity, *Monsoons, *Lakes, Secchi disks, Light intensity, Artificial lakes, Photosynthesis, Euphotic zone, Sri Lanka.

The relationship between phytoplankton primary production and seasonality of physico-chemical parameters were examined for five man-made lakes in the dry-zone of Sri Lanka. Sri Lanka experiences two monsoons dividing the year into four meteorological seasons: the North East (October - December) and South West (April - June) monsoons and the two inter-monsoons. A significant log linear relationship was found between Secchi disc depth and the depth of the euphotic zone which was lowest during the NE monsoon. Maximum mean photosynthetic rate ranged from 0.935 +/- 0.067 SE to 0.479 mg O2/L/h +/- 0.115. Gross primary productivity which ranged from 0.378 g O2/sq m/h in the NE monsoon to 0.980 g O2/sq m/h in the SW monsoon showed significant season variation. This is shown to be determined either directly or indirectly by the light regime. (Author's abstract)
W88-09692

DAPHNIA SIZE STRUCTURE, VERTICAL MIGRATION, AND PHOSPHORUS REDISTRIBUTION,
Notre Dame Univ., IN. Dept. of Biological Sciences.
M. L. Dini, J. O'Donnell, S. R. Carpenter, M. M. Elser, and J. J. Elser.

Hydrobiologia HYDRB8, Vol. 150, No. 2, p 185-191, July 20, 1987. 4 fig, 17 ref. NSF Grant BSR-83-08918.

Descriptors: *Lakes, *Waterfleas, *Limnology, *Daphnia, *Vertical distribution, *Migration, *Phosphorus, *Phosphorus removal, Nutrient removal, Aquatic populations, Excretion, Thermal stratification, Crustaceans.

The timing and magnitude of diel migration in two daphnid assemblages were determined from a series of vertical profiles of daphnid size distribution. Animals were collected concurrently for gut fullness determination. Only large daphnids (> 1.4 mm) migrated, but these animals could account for substantial vertical and diel differences in phosphorus excretion rate. Gut fullness measurements and time courses of diel vertical migration suggested that large Daphnia can cause a net downward flux of phosphorus during summer in thermally stratified lakes. (Author's abstract)
W88-09693

FISH PREDATION, LAKE ACIDITY AND THE COMPOSITION OF AQUATIC INSECT ASSEMBLAGES,
Canadian Wildlife Service, Ottawa (Ontario).
For primary bibliographic entry see Field 5C.
W88-09694

LIMNOLOGY OF A HYPERTROPHIC RESERVOIR STORING WASTEWATER EFFLUENT FOR AGRICULTURE AT KIBBUTZ NA'AN, ISRAEL,
Hebrew Univ., Jerusalem (Israel). Dept. of Zoology.
For primary bibliographic entry see Field 5D.
W88-09695

PRIMARY PRODUCTION AND NUTRIENT AVAILABILITY IN WET HEATHLAND ECOSYSTEMS,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
F. Berendse, B. Beltman, R. Bobbink, R. Kwant, and M. Schmitz.
Acta Oecologia AOSPDY, Vol. 8(22), No. 3, p 265-279, 1987. 2 fig, 6 tab, 16 ref.

Descriptors: *Primary productivity, *Nutrients, *Ecosystems, *Heathlands, *Shrubs, *Wetlands, *Cycling nutrients, Nitrogen, Phosphorus, Phosphates, Mineralization, Biomass, The Netherlands, Litter, Decomposing organic matter.

A comparative study was carried out on productivity, nitrogen and phosphorus uptake and nitrogen and phosphate mineralization in wet heathlands (central Holland) dominated by either Molinia caerulea (L.) Moench or Erica tetralix L. Total annual production was estimated from regular measurements of the biomass of different plant parts. The mineralization of nitrogen and phosphorus was measured by incubation of undisturbed soil columns in the field. The mean above-ground production of Molinia (513 g/sq m/yr) was about 40% higher than that of Erica (355 g/sq m/yr). Estimates of below-ground production were depended strongly on how they were calculated. In each case, however, root production in Molinia was higher than that in Erica. The nitrogen mineralization was similar in both communities (10-13 g N/sq m/yr). The mineralization is so high due to the large amount of humus and litter that had accumulated. The phosphate mineralization was equal in the two communities during 1982 (0.8-0.9 g P/sq m/yr), but in 1983 it was higher in communities dominated by Molinia. The higher above-ground production in Molinia can be explained almost completely on the basis of the larger quantities of nitrogen and phosphorus that are withdrawn from dying plant parts at the end of the growing season and reused at the beginning of the new growing period. On the basis of comparisons between nitrogen and phosphate mineralization rates and annual external input of these two nutrients, it can be concluded that in both communities about 75% of the nitrogen and about 95% of the phosphate that is available for uptake by plants is delivered by the decomposition of plant litter and humus. (Author's abstract)
W88-09698

FRESHWATER MUSSELS (UNIONIDAE) OF THE UPPER OHIO RIVER, GREENUP AND BELLEVILLE POOLS, WEST VIRGINIA,
West Virginia Dept. of Natural Resources, Charleston. Div. of Water Resources.
M. A. Zeto, W. A. Tolin, and J. E. Schmidt.
The Nautilus NUTLA5, Vol. 101, No. 4, p 182-185, Nov. 6, 1987. 1 fig, 2 tab, 10 ref.

Descriptors: *Navigable rivers, *Ohio River, *Mussels, *Aquatic populations, Population density, Species diversity, West Virginia, Greenup Pool, Belleville Pool, West Virginia, Endangered species.

A preliminary survey of freshwater mussels inhabiting areas around the Ohio River islands of West Virginia was conducted in 1983 by the U.S. Fish and Wildlife Service, assisted by the West Virginia Department of Natural Resources. This survey concluded that the Greenup and Belleville Pools displayed a far greater abundance and diversity of mussels than the remaining navigational pools along West Virginia, and warranted further investigation. During the spring and summer months of 1985, numerous collections were made at various points within the two navigational pools to expand the data previously collected. Twenty-four species of unionid mussels and Corbicula were collected from these areas, representing 16 and 23 species from the Greenup and Belleville Pools, respectively. The Greenup Pool has a more evenly dispersed favnal representation than the Belleville Pool; this may be attributed to the smaller amount of industrialization and greater isolation of the study area of the Greenup Pool, resulting in fewer negative impacts to the river. No species on the federal endangered species list were encountered, however four of the species collected are considered endangered by the State of Ohio. (Vernooy-PTT)
W88-09700

NITRATE ENHANCEMENT OF NITRIFICATION DEPTH IN SEDIMENT/WATER MICROCOSMS,
Oxford Univ. (England). Soil Science Lab.
For primary bibliographic entry see Field 5B.
W88-09706

TRACE METAL DYNAMICS IN A SEASONALLY ANOXIC LAKE,
Freshwater Biological Association, Ambleside (England).
K. Morfett, W. Davison, and J. Hamilton-Taylor.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 107-114, February 1988. 5 fig, 3 tab, 27 ref.

Descriptors: *Water chemistry, *Trace metals, *Fate of pollutants, *Lakes, *Anoxic lakes, Lake sediments, Sediment-water interfaces, Seasonal variation, Esthwaite Water, England, Metals, Interstitial water, Sample preservation, Water sampling, Iron, Manganese, Organic carbon, Cadmium, Copper, Lead, Zinc, Hydrogen ion concentration, Decomposing organic matter.

Selected results are presented from a detailed 12-month study of trace metals in Esthwaite Water, a seasonally anoxic lake in northwest England. Dissolved concentrations of Fe, Mn, organic carbon, Cd, Cu, Pb, Zn, and pH were determined in both oxic and anoxic lake water and in anoxic interstitial waters subsequent to their extraction. The problem of potential modification of the samples by exposure to oxygen, in addition to the usual direct contamination problems associated with low-level trace metal analysis, were solved using the novel sampling and handling techniques developed. Equipment preflushed with N2 was used which eliminated the need for the conventional glove box and centrifuge techniques and which resulted in less handling of samples, faster subsampling of cores, and reduced possibility of sample contamination by oxygen or metal ions. Trace metal concentrations remained low throughout the year in both water column and pore waters. There was evidence for some remobilization at the sediment-water interface but sediments deeper than 3 cm acted as a sink throughout the year. Variations in the metal concentrations in the water were largely associated with increased loading during periods of heavy rainfall. During the summer, concentrations of Cu and Zn in the waters overlying the sediments were enhanced by release from decomposing algal material. Similarly, enhanced concentrations of Cd, Cu, Pb, and Zn were observed during periods of much reduced mixing during ice-cover. Although there were large seasonal variations in the concentrations of dissolved and particulate Fe and Mn, there were no comparable changes in the concentrations of trace metals. (Wood-PTT)
W88-09708

SEASONAL VARIATIONS IN THE LOOSELY SORBED PHOSPHORUS FRACTION OF THE SEDIMENT OF A SHALLOW AND HYPEREUTROPHIC LAKE,
Aarhus Univ. (Denmark). Botanical Inst.
For primary bibliographic entry see Field 5B.
W88-09709

IMPORTANCE OF STREAMLINING IN INFLUENCING FISH COMMUNITY STRUCTURE IN CHANNELIZED AND UNCHANNELIZED REACHES OF A PRAIRIE STREAM,
Iowa State Univ., Ames. Dept. of Animal Ecology.
For primary bibliographic entry see Field 6G.
W88-09725

NOTE ON THE PROBLEM OF USING BIOLOGICAL SURVEYS TO ASSESS WATER QUALITY IN SMALL ALPINE TORRENTS,
Milan Univ. (Italy). Ist. di Biologia.
For primary bibliographic entry see Field 5A.
W88-09727

SEASONAL PATTERNS OF SUSPENDED BACTERIA AND ALGAE IN TWO NORTHERN CALIFORNIA STREAMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
G. A. Lamberti, and V. H. Resh.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 1, p 45-57, July 1987. 5 fig, 3 tab, 35 ref.

Descriptors: *Bacteria, *Algae, *Seston, *Seasonal variation, *California, Stream biota, Chlorophyll a, Water analysis, Chemical properties, Temperature effects, Geothermal studies, Detritus.

Seasonal dynamics of suspended bacteria were studied for 24 months in two third-order California, streams. In Big Sulphur Creek, a natural geothermal tributary (which increased water temperature and altered water chemistry) elevated chlorophyll a levels 10-fold and numbers of suspended bacteria 3-fold during most months. Chlorophyll a was highest (1-2 micrograms/l) in spring and summer, but bacterial numbers showed little temporal variation (100,000 cells/ml year-round). Little Sulphur Creek, a stream located in an adjacent drainage that lacks significant geothermal activity, had low levels of suspended chlorophyll a (<0.5 micrograms/l) during most months. Little Sulphur Creek had high numbers of suspended bacteria only in autumn (1,000,000 cells/ml), which probably resulted from the decomposition of allocthonous detritus. (Author's abstract)
W88-09748

RESPONSE OF THE PHYTOPLANKTON COMMUNITY TO WEEKLY ADDITIONS OF MONOAMMONIUM PHOSPHATE IN A DYSTROPHIC LAKE,
Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W88-09750

RELATIONSHIP BETWEEN ALGAL DRIFT, DISCHARGE AND STREAM ORDER IN A BOREAL FOREST WATERSHED,
National Museum of Natural Sciences, Ottawa (Ontario). Botany Div.
P. B. Hamilton, and H. C. Duthie.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 2, p 275-289, August 1987. 5 fig, 4 tab, 21 ref.

Descriptors: *Aquatic plants, *Algae, *Stream order, *Limnology, *Storms, *Aquatic drift, Phytoplankton, Climatology, Biomass, Diurnal distribution, Forest waterheds.

Algal drift in a pristine boreal forest stream system was investigated to determine the relationship between diurnal drift pattern and stream order, the impact of storm events, and the relative importance of euplanktonic algae. A first and second order stream showed distinct diurnal rhythms in algal biomass with the maxima of several species occurring at or soon after mid-day. Although a sixth order stream showed no diurnal pattern in total biomass, several of the component species did. Response to a storm event varied with stream order. A first order stream showed a rapid increase in cell numbers followed by a rapid recovery as discharge decreased. A second order stream had a more buffered response. In a sixth order stream, the response was delayed for several hours. Epilithic diatoms were predominant in the storm drift of all the streams. Euplanktonic algae increased in importance with increasing stream order and decreased in importance during storms. The results support the hypothesis that algal drift is related to rhythms in cell division and not primarily to physical factors. The stress of storm events temporarily disrupts this diurnal rhythm, with a rapid recovery of the drift to pre-storm levels. (Author's abstract)
W88-09751

ROLE OF FISH AND BENTHOS IN THE NITROGEN BUDGET OF LAKE BALATON, HUNGARY,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
I. Tatrai.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 2, p 291-302, August 1987. 2 fig, 6 tab, 29 ref.

Descriptors: *Benthos, *Midges, *Fish, *Nitrogen budget, *Chemical properties, *Lake Balaton, Aquatic animal, Aquatic insects, Aquatic plants, Phytoplankton, Nutrients, Metabolism, Ammonia, Excretion, Hungary, Aquatic life.

The role of the benthophagous fish, bream, (Abramis brama L.,) and benthic Chironomidae in the nitrogen budget of Lake Balaton has been studied. It was found that fish excrete significant amount of ammonia which then becomes available for phytoplankton. The metabolic release rate of ammonia ranged between 0.3-27.6 mg per individual per day, depending on fish size and mean monthly water temperature of Lake Balaton. The estimated annual release rate of ammonia by chironomid larvae from aerobic sediments was 4 grams per square meter. Fish excretion and chironomid release make up to 20% of the total annual nitrogen load to Lake Balaton. (Author's abstract)
W88-09752

LAKE TITICACA (PERU/BOLIVIA) PHYTOPLANKTON: SPECIES COMPOSITION AND STRUCTURAL COMPARISON WITH OTHER TROPICAL AND TEMPERATE LAKES,
California Univ., Davis. Inst. of Ecology.
H. J. Carney, P. J. Richerson, and P. Eloranta.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 3, p 365-385, September 1987. 3 fig, 4 tab, 55 ref, append.

Descriptors: *Lake Titicaca, *Aquatic plants, *Phytoplankton, Algae, Diatoms, Cyanophyta, Chlorophyta, Species composition, Primary productivity, Population density, Peru, Bolivia, Tropical regions.

Phytoplankton of Lake Titicaca were collected biweekly during 1981-82. 170 species were found (including 86 Chlorophyceae, 47 Bacillariophyceae, and 19 Cyanophyceae). 128 species are new records. A genus-level florisitc comparison with 31 other lakes indicated that the Lake Titicaca flora is substantially different in composition from flora of temperate and most tropical lakes. However, the phytoplankton of Lake Titicaca and four other Andean lakes are relatively similar. Epilimnetic phytoplankton wet weight (mean = 511 mg/cu m) and chlorophyll a (mean = 2.6 micrograms/l) indicate that Lake Titicaca is meso-oligotrophic, but mean annual primary productivity is relatively high. Relative abundance curves for dominant species are similar to curves for other tropical and temperate lakes. (Author's abstract)
W88-09754

SEASONAL PATTERNS AND WATER QUALITY IN KING TALAL RESERVOIR, JORDAN,
Jordan Univ., Amman. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5B.
W88-09755

POPULATION DYNAMICS OF THE PHYTOPLANKTON COMMUNITY IN DOH-HOH-NUMA BOG, TSUKUBA CITY, JAPAN,
Tsukuba Univ. (Japan). Inst. of Biological Sciences.
Q. Liu, and H. Seki.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 4, p 481-497, October 1987. 9 fig, 37 ref.

Descriptors: *Water pollution effects, *Aquatic plants, *Phytoplankton, *Population dynamics, *Doh-Hoh-Numa Bog, *Bogs, Limnology, Growth, Aquatic habitat, Tsukuba City, Japan, Ammonium, Phosphate, Nitrate, Temperature effects.

Function of the bog environment on population dynamics of the phytoplankton community was studied in Doh-Hoh-Numa Bog, Tsukuba Science City, Japan, as indicated by the phytoplankton growth. The influences of physiochemical and biological environmental factors were analyzed and discussed in relation to the growth rates of predominant phytoplankters, where the growth rate of each phytoplankton species was determined by both the in situ method and the simulated in situ method using a chemostat. Ammonium was identified as the limiting factor for the population growth of the predominant phytoplanton with phosphate and nitrate having the most profound effect on their growth among the non-limiting factors. Grazing pressure also had an important effect on the population dynamics, and was always detected one month following the formation of phytoplankton bloom. (Hammond-PTT)
W88-09757

PRELIMINARY OBSERVATIONS ON PRIMARY PRODUCTIVITY AND PHYTOPLANKTON ASSOCIATIONS IN THE VAAL RIVER AT BALKFONTEIN, SOUTH AFRICA,
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Botany.
A. J. H. Pieterse, and J. C. Roos.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 4, p 499-518, October 1987. 3 fig, 6 tab, 44 ref.

Descriptors: *Aquatic plants, *Phytoplankton, *Primary productivity, *Turbidity, *Productivity, *Vaal River, Diatoms, Cryptophyta, Chlorophyta, Biomass, Photosynthesis, Climate, Light intensity, Hydrology, Mathematical analysis, Balkfontein, South Africa.

The Vaal River represents a turbid system with light extinction coefficients ranging between 2.7 and 6.2/m; the depth of the photic zone ranged between 0.7 and 1.7 m. Significant levels of production were restricted to the upper 1 m, maximum productivity in the depth profile, occurred between 0.0 and 0.25 m depths, while the onset of light saturation occurred at light intensities between 320 and 600 microEinsteins/sq m/sec. Midday integral rates of primary productivity ranged between 18 and 288 mg C/sq m/hour, daily rates of areal photosynthesis between 147 and 2047 mg C/sq m/day, and daily rates of areal photosynthesis in the photic zone between 203 and 1204 mg C/cu m/day. Integral rates of primary productivity and daily rates of areal photosynthesis positively correlated with Secchi disc depths and total dissolved substances, and negatively with light extinction coefficients. Photosynthetic capacity ranged between 5 and 21.6 mg C/mg chlorophyll a/hour and photosynthetic efficiency between 0.013 and 0.017 mg C/mg chlorophyll a/hour/(microEinstein/sq m/sec). Estimates of quantum yields (based on cosine irradiance) ranged between 0.0003 and 0.0006 moles C/sq m Einstein absorbed/mg chlorophyll a, and quantum yields between 0.02 and 0.04 moles C/Einstein absorbed. Solar energy conversion efficiencies indicated that the percent conversion efficiency of PAR ranged between 0.03 and 0.63. A centric diatom dominated mixed algal association assimilated C more efficiently than a chlorophyte dominated mixed algal association. A spring bloom, dominated by chlorophyte flagellates, displayed high productivity values under relatively clear water conditions, but assimilated C only slightly more efficiently than a cryptophyte dominated association which occurred under conditions of high turbidity. Turbidity, and thus subsurface light-climate, together with total dissolved substances, appear to be more important factors in the control of phytoplankton biomass and productivity than temperature. (Author's abstract)
W88-09758

PELAGIC PREDATORS AND INTERFERING ALGAE: STABILIZING FACTORS IN TEMPERATE EUTROPHIC LAKES,
Oslo Univ. (Norway). Zoological Museum.
A. Brabrand, B. Faafeng, and J. P. M. Nilssen.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 4, p 533-552, October 1987. 11 fig, 54 ref.

Descriptors: *Cycling nutrients, *Limnology, *Eutrophic lakes, Phytoplankton, Crustaceans, Fish, Roach, Aquatic plants, Cyanophyta, Predation, Water properties, Chemical properties, Temperature, Lake Gjersjoen.

Two large pelagic limnocorrals were installed in Lake Gjersjoen, SE Norway, in 1979 (diameter 10 m, depth 12 m) and 1980 (diam. 10 m, depth 20 m). The walls consisted of transparent polyethylene foil (thickness 0.15 mm) and the bottom was covered by netting of mesh size 7.9 mm. The corrals were supported by oil-spill booms and surrounded by wooden docks. Temperature, oxygen and pH stratifications in the corrals generally mimicked the conditions in the lake in 1979 and 1980, although the thermocline in the corrals was situated slightly closer to the surface. The effect of fish removal on zooplankton community structure and interfering algae (Oscillatoria) was investigated during 1979 and 1980. Juvenile roach (Rutilus rutilus) (mostly of age 2+) equivalent to approximately 230 kg/ha were added to one of the enclosures in 1979 and 1000 kg/ha in 1980, while there were no fish in the other corral. The absence of fish had apparently no major effect on water chemistry, phytoplankton and zooplankton, and the enclosures closely resembled the lake during autumn 1979. The experiments in 1980, initiated during the spring phytoplankton peak, gave high abundance of carnivorous cyclopoid copepods in the enclosure without fish. This was followed by even lower numbers of efficient filter-feeders than in the lake, in which fish were the main zooplankton predator. As a result, filter-feeders were unable to influence successional patterns and species composition of phytoplankton, even when roach were absent. (Author's abstract)
W88-09759

ZOOPLANKTON CONSUMPTION OF BACTERIA IN A EUTROPHIC LAKE AND IN EXPERIMENTAL ENCLOSURES,
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
O. Geertz-Hansen, M. Olesen, P. K. Bjornsen, J. B. Larsen, and B. Riemann.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 4, p 553-563, October 1987. 3 fig, 2 tab, 35 ref.

Descriptors: *Bacteria, *Limnology, *Eutrophic lakes, Crustaceans, Fish, Rotifers, Predation, Pro-

ductivity, Trophic level, aquatic animals, Zooplankton, Lake Hylke, Food chains.

Bacterioplankton net production, biomass and zooplankton ingestion rate of bacteria were followed during a spring and autumn period in eutrophic Lake Hylke, Denmark, and in 7 cu m experimental enclosures. In the lake, bacterioplankton net production, ranged between 5 and 70 micrograms C/l/day, and crustacean zooplankton > 200 micrometers consumed from 23 to 66% of the bacterial production. Trophodynamic aspects of zooplankton consumption of bacteria were studied in enclosures manipulated with fish and nutrients. In enclosures without fish predation, the crustacean zooplankton ingestion balanced the bacterial net production. Small zooplankton (between 50 and 200 micrometers, mainly rotifers) contributed only 20% of the total zooplankton (> 50 micrometers) ingestion of bacteria in the lake. In the presence of planktivorous fish, however, small plankton gradually became the dominant bacterial consumers. (Author's abstract)
W88-09760

CHARACTERIZATION OF LIGHT REGIME CHANGES (PAR) BY IRRADIANCE REFLECTANCE IN TWO AMAZONIAN WATER BODIES WITH DIFFERENT PHYSICO-CHEMICAL PROPERTIES,
Kiel Univ. (Germany, F.R.). Botanisches Inst.
B. Furch, and K.-R. Otto.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 4, p 579-587, October 1987. 5 fig, 1 tab, 10 ref.

Descriptors: *Lakes, *Trophical regions, *Limnology, *Radiation, *Physicochemical properties, *Amazonia, Seasonal variation, Photosynthesis, Underwater sensors.

The downward and upward radiation in two water bodies of Central Amazonia were measured in terms of quanta (PAR), with cosine corrected underwater sensors. The whitewater (entry of Lago Camaleao) and the blackwater (Taruma Mirim) lakes are connected to the adjacent Rio Solimoes (= Amazon) and Rio Negro, respectively, by an inflow/outflow channel such that their water levels can fluctuate in response to the river levels, often by more than 10 m. To clarify methodological difficulties of measuring underwater irradiance, an additional spectroradiometer was placed in a clear, oligotrophic lake in norther Germany. In spring, summer and fall the light regimes of the two tropical water types, are well characterized by their irradiance reflectance (ratio of upward to downward radiation, PAR). (Hammond-PTT)
W88-09761

DISSOLVED ORGANIC MATTER IN COLORED WATER FROM MOUNTAIN BOG POOLS IN JAPAN: I. SEASONAL CHANGES IN THE CONCENTRATION AND MOLECULAR WEIGHT DISTRIBUTION,
Yamagata Univ. (Japan). Dept. of Chemistry.
Y. Satoh, S. Shoji, H. Satoh, and M. Takanashi.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 4, p 589-603, October 1987. 5 fig, 1 tab, 45 ref.

Descriptors: *Limnology, *Organic Matter, *Bogs, *Wetlands, *Chemical properties, *Seasonal variation, *Japan, Nutrients, Dissolved organic carbon, Dissolved carbohydrate, Temperature effects, Water temperature.

Changes in the concentrations of nutrients, dissolved organic carbon and dissolved carbohydrate in four bog pools and changes in the molecular weight distribution of dissolved organic carbon and dissolved carbohydrate in one bog pool of Shibakusa-daira, which is an ombrotrophic mountain bog in northeast Japan, were observed from 10 June to 21 Oct., 1982. The concentrations of nutrients have been extremely low; rainwater seems to be the only source of nutrients. The concentrations of dissolved organic carbon and dissolved carbohydrate were significantly high as compared with those in other water bodies. The controlling factors for the concentrations of dissolved organic carbon and dissolved carbohydrate are primarily water temperature, and water exchange during and after heavy rain. The fraction of which molecular weight was more than 100,000 was of most importance in total dissolved organic carbon pools. This also was true for dissolved carbohydrate, however, the importance of this fraction was more evident for dissolved carbohydrate than for dissolved organic carbon. The importance of carbohydrate as a constituent of the dissolved organic carbon pool is greater in the higher molecular weight fraction than in the lower molecular weight fraction. (Author's abstract)
W88-09762

PHASED CELL DIVISION BY A FIELD POPULATION OF STAURASTRUM LONGIRADIATUM (CONJUGATOPHYCEAE, DESMIDIACEAE),
Instituto de la Grasa y sus Derivados, Seville (Spain).
M. A. Cobelas, J. L. Velasco, A. Rubio, and A. J. Brook.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 1, p 1-20, March 1988. 9 fig, 3 tab, 35 ref.

Descriptors: *Aquatic plants, *Chlorophyta, *Cell division, *Growth, *Lakes, Phytoplankton, Desmids, Field population, Advection, Reservoir, Spain, Eutrophication.

A naturally occurring population of the planktonic desmid Staurastrum longiradiatum has been shown to develop phased cell division in an eutrophic reservoir near Madrid (Spain) during early stratification. Cell divisions, as shown by cytokinesis, were mostly observed between 15:00 and 19:00 hrs. Growth rates based on the frequency of division were fairly constant throughout the study, whereas population growth rates partly depended upon advection processes. Divisions were independent of both population density and weather conditions, but the division cycle could not be ascribed to any particular biological determinant. (Author's abstract)
W88-09764

SEASONAL CHANGES IN BIOMASS AND PRODUCTION OF PERIPHYTON GROWING UPON REED IN LAKE MAARSSEVEEN I,
Amsterdam Univ. (Netherlands). Subfaculteit Tandheelkunde.
J. T. Meulemans.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 1, p 21-42, March 1988. 13 fig, 1 tab, 45 ref.

Descriptors: *Wetlands, *Reed, *Periphyton, *Primary production, *Seasonal variation, *Lake Maarsseveen, Growth, Biomass, The Netherlands, Plant physiology, Productivity.

Changes in periphytic biomass growing upon reed was measured from 1981-1983 in Lake Maarseveen. Dependent on the growth conditions of reed, periphyton reached its maximum biomass either in winter or spring (max. 50 g ash free dry weight/sq m substratum). An incubator was constructed for periphytic production measurements (oxygen method) in the field. Periphytic production was relatively high for a short period in spring (0.6 g C/sq m littoral zone per day). The initial slope of the P vs. I-curve (oxygen production/chlorophyll vs. light intensity) was highly dependent on the density of the incubated periphytic biomass per unit substratum. The yearly primary production was estimated to be 67 g C/sq m of littoral zone and 558 kg C per total lake surface of the littoral zone. Annual epiphytic production on reed in this lake is less than 1% of total annual phytoplankton production. (Author's abstract)
W88-09765

NITROGEN METABOLISM IN LAKE KIZAKI, JAPAN: V. THE ROLE OF NITROGEN FIXATION IN NITROGEN REQUIREMENT OF PHYTOPLANKTON,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
M. Takahashi, and Y. Saijo.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 1, p 43-54, March 1988. 3 fig, 5 tab, 23 ref.

Descriptors: *Lakes, *Limnology, *Phytoplankton, *Plant metabolism, *Plant physiology, *Nitrogen fixation, Lake Kizaki, Nutrients, Nitrogen, Ammonium, Nitrates, Japan, Nitrogen isotopes, Radioactive tracers, Tracer studies, Algae, Seasonal variation.

In situ nitrogen fixation, and ammonium and nitrate uptake by phytoplankton in Lake Kizaki, in which the blue green alga, Anabaena spp. dominated in summer, were measured using the N15 tracer method in 1983. Nitrogen fixation rate was detectable from July to September and its maximum was reached in August. Nitrogen fixation rates were generally < 10% of those of ammonium uptakes, though the fixation rates at the deepest part of the trophogenic zone was fairly similar to those of ammonium uptake in August. In this layer, the nitrogen fixation process was an important nitrogen source for phytoplankton. The effect of ammonium and nitrate on nitrogen fixation was investigated. In the presence of ammonium at 1-2 microgram atom N/l, nitrogen fixation was completely suppressed, while nitrate did not affect nitrogen fixation where it was present even in relatively high concentration (> 10 microgram atom N/l). Ammonium was preferentially used by phytoplankton, so that the in situ ammonium uptake rare where concentration was 1-2 microgram atom N/l was almost sufficient to meet the nitrogen requirement of phytoplankton. In such situations, nitrogen uptake by fixation should not be required. However, the nitrate uptake was often suppressed with ammonium at concentrations < 0.5 microgram atom N/l, and hence the nitrogen requirement of phytoplankton would be satisfied by nitrogen fixation, but not with nitrate even at a high concentration. (Author's abstract)
W88-09766

PATTERNS OF ACCUMULATION OF ALKALINE-EARTH METALS IN THE TISSUE OF THE FRESHWATER MUSSEL VELESUNIO ANGASI (SOWERBY),
Commonwealth Scientific and Industrial Research Organization, Lucas Heights (Australia). Lucas Heights Research Labs.
R. A. Jeffree.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 1, p 67-90, March 1988. 9 fig, 5 tab, 26 ref.

Descriptors: *Bioaccumulation, *Aquatic animal, *Molluska, *Mussels, *Alkaline earth metals, Animal metabolism, Animal physiology, Accumulation, Chemical analysis, Hydrogen phosphate, Barium, Calcium, Magnesium, Radium Radioisotopes, Limnology, Australia, Magela Creek, Alligator River, Population exposure, Tissue analysis.

The pattern and rates of accumulation, under natural conditions, of the alkaline-earth metals Ra226, Ba, Ca and Mg in the tissue of freshwater mussels (Velesunio angasi) of increasing size and age were investigated in three populations from Magela Creek in the Alligator Rivers Uranium Province of the Northern Territory, Australia. Whereas the Ra226, Ba and Ca tissue concentrations generally increased with size and age of the mussels, the Mg tissue concentration remained constant or declined. Differences between populations in the rates of accumulation of Ra226 and Ba with size, age and Ca tissue concentration could be explained by different size/age relationships and ratios of Ra226 or Ba to Ca water concentrations between mussel populations. Positive correlations between both Ra226 and Ba with Ca tissue concentrations support the hypothesis that these non-essential elements are metabolic analogues of Ca; for Mg fewer and less significant correlations were less supportive of the hypothesis that Ra226 and Ba were metabolic analogues of Mg. Comparison between the rates of accumulation of the elements in mussel tissue gave the sequence Ra226 > Ba = Ca > Mg for mussels from two populations. The rate of accumulation was correlated with the stability constant of the hydrogen phosphate of the alkaline-earth metal. These data support the hypothesis that the differential rates of retention of alkaline-earth metals as phosphates in the granular deposits in tissue are directly related to their solubility. (Author's abstract)

W88-09768

WAVE EFFECTS ON THE BOTTOM BIOCOENOSES IN THE ONEGA LAKE BAYS,
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
I. M. Raspopov, T. D. Slepukhina, F. F. Vorontzov, and O. N. Dotzenko.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 1, p 115-124, March 1988. 5 fig, 11 ref.

Descriptors: *Hydrology, *Waves, *Benthos, *Currents, *Sedimentation, *Onega Lake, Aquatic animals, Aquatic plants, Invertebrates, Macrophytes, Sediments, Organic matter, Soviet Union.

Biocoenoses of benthos have been studied in two small bays (40.0 and 33.6) of Onega Lake (Soviet Union) with sharply different water dynamics. formulae for maximum bottom velocities were checked by field data. The difference between calculated and measured quantities averaged + or - 14%, the correlation coefficient being 0.92. Gaps in the Phragmites australis growth were observed were maximum bottom velocities were high enough to wash out bottom sediments, and the inlake boundary of the growth band coincides with the isolines connecting the coefficients of maximum load (2000 gram.force) on reed stems. Phytocoenoses of Nuphar lutea are observed in places where maximum bottom velocity was <0.2 m/s. An excessive accumulation of organic matter in sediments due to low mobility of the bottom water layer is a factor that limits the development of plants and invertebrate species in the guba Glubokaya, with its slowed-up water dynamics. In the Pens guba the develoment of flora and fauna is limited by intensified water dynamics, with resulting washing-out of nutrients from the ground, and instability of the substrate where organisms live. (Hammond-PTT)
W88-09769

AMINO ACIDS AS A NITROGEN SOURCE OF GROWTH OF OSCILLATORIA RUBESCENS D. C.: ECOLOGICAL SIGNIFICANCE,
Polish Academy of Sciences, Mikolajki. Inst. of Ecology.
H. M. Krupka, and M. Feuillade.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 1, p 125-142, March 1988. 7 fig, 5 tab, 56 ref.

Descriptors: *Aquatic plants, *Cyanophyta, *Nutrition, *Eutrophication, *Amino acids, *Nitrogen, *Plant metabolism, *Plant physiology, Phytoplankton, Nutrients, Arginine, Serine, Valine, Lysine, Alanine, Glycine, Aspartic acid, Threonine, Glutamic acid.

Utilization of arginine, serine, valine, lysine, alanine, glycine, aspartic acid, threonine and glutamic acid, alone or in mixtures, as the only source of nitrogen by Oscillatoria rubescens, was investigated under laboratory conditions. At high concentrations of amino acids applied in batch cultures, and at low concentrations used in continuous cultures, only arginine was used for growth. Special attention was paid to chemical decomposition of amino acids in the medium. Toxic effects of valine, aspartic acid, alanine and threonine were observed at high concentrations. The present results suggest that the amino acids occurring in lake waters are not an N source for O. rubescens, because arginine, the only amino acid supporting growth, does not occur in lake waters. The presence and success of Oscillatoriaceae in eutrophic and hypertrophic waters most likely are not due to a single environmental factor, but that increasing N and P loads create conditions favorable for their growth. (Author's abstract)
W88-09770

IMPACT ON THE SENJOGAHARA ECOSYSTEM OF EXTREME RUN-OFF EVENTS FROM THE RIVER SAKASAGAWA, NIKKO NATIONAL PARK: II. THE CORRELATION OF VEGETATION AND ENVIRONMENTAL DISTURBANCE USING TWINSPAN AND DCA ORDINATION TECHNIQUES,
Tokyo Univ. of Agriculture and Technology (Japan). Faculty of Agriculture.
For primary bibliographic entry see Field 2E.
W88-09771

EFFECT OF TUBIFICIDS AND CHIRONOMIDS ON PARTICLE REDISTRIBUTION OF LAKE SEDIMENT,
Niigata Univ. (Japan). Biological Lab.
For primary bibliographic entry see Field 2J.
W88-09772

LIMNOLOGICAL CHARACTERISTICS OF THE AREAS OF CAPTURE OF 'MANJUBA' ANCHOVIELLA LEPIDENTOSTOLE (FOWLER, 1911) (OSTEICHTHYES, ENGRAULIDAE), IN RIBEIRA DE IGUAPE RIVER FROM REGISTRO (SP) (CARACTERISTICAS LIMNOLOGICAS DE AREAS DE CAPTURA DE MANJUBA ANCHOVIELLA LEPIDENTOSTOLE (FOWLER, 1911) (OSTEICHTHYES, ENGRAULIDAE), NO RIO RIBEIRA DE IGUAPE, EM REGISTRO (SP)),
Instituto de Pesca, Santos (Brazil). Secao de Aquicultura.
M. T. D. Giamas, H. Vermulm, and M. Takino.
Boletim do Instituto de Pesca, Vol. 13, No. 1, p 77-87, June 1986. 1 fig, 9 tab, 10 ref.

Descriptors: *Rivers, *Limnology, *Aquatic animals, *Fish, *Physicochemical properties, Turbidity, Conductivity, Electrical properties, Silica, Calcium, Alkalinity, Ribeird de Iguape River, Brazil.

The capture of 'manjuba' (Anchoviella lepidentostole) and physical and chemical parameters of the water of Ribeira de Iguape River at 3 locations (Boa Vista, Ponte, and Praia do Numa) in Registro municipality (Soa Paulo, Brazil) are discussed. Samples were collected from October 1978 to September 1979. The locations and times in which the biggest captures occurred are reported. The most significant differences noted were among the limnological factors turbidity, electrical conductivity, alkalinity, and silica and calcium content. (Author's abstract)
W88-09774

ECOLOGY OF JACARE PEPIRA RIVER BASIN (47 DEG 55 MIN - 48 DEG 55 MIN W AND 22 DEG 30 MIN - 21 DEG 55 MIN S): PHYSIOGRAPHY (GEOMORPHOLOGY, GEOLOGY, PEDOLOGY AND HYDROGRAPHY) AND SOIL USE (ECOLOGIA DA BACIA DO RIO JACARE PEPIRA (47 DEG 55 MIN - 48 DEG 55 MIN W E 22 DEG 30 MIN - 21 DEG 55 MIN S): FISIOGRAFIA (GEOMORFOLOGIA, GEOLOGIA, PEDOLOGIA E HIDROLOGIA) E USO DO SOLO),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
M. H. Maier, and M. Tolentino.
Boletim do Instituto de Pesca, Vol. 13, No. 1, p 121-133, June 1986. 1 fig, 12 ref.

Descriptors: *Ecosystems, *Hydrography, *Rivers, *Physiography, *Geology, *Geomorphology, *Jacare Pepira River Basin, Catchment basins, Brazil, Soils, Maps, Vegetation, Land use, Chemical composition.

This paper is part of a study of Jacare Pepira River Basin ecosystem, Brazil. The basin is 2612 sq km. Its main channel is formed around 22 deg 30 min S and 47 deg 55 min W at 960 m altitude and discharges into the Tiete River on the right banks (21 deg 55 min S and 48 deg 55 min W, 400 m altitude). The terrestrial sub-system study was based mainly on the interpretative method of map superpositions. Through description and interpretations of the interrelationships among the physiographic elements themselves and among the physiographic elements and the soil use in adjacent areas, the recomposition of the hydrography of the Jacare Pepira Basin is presented. Vegetation, land use, and water chemistry are discussed. (See W88-09776 thru W88-09777) (Author's abstract)
W88-09775

ECOLOGY OF JACARE PEPIRA RIVER BASIN: MAJOR IONS (SAO PAULO STATE OF BRAZIL) (ECOLOGIA DA BACIA DO RIO JACARE PEPIRA: IONS DOMINANTES, SAO PAULO, BRASIL),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
M. H. Maier, M. Takino, and M. Tolentino.
Boletim do Instituto de Pesca, Vol. 13, No. 1, p 135-151, June 1986. 2 fig, 5 tab, 42 ref.

Descriptors: *Ecosystems, *Jacare Pepira River Basin, *Water chemistry, *Rivers, *Ions, Conductivity, Electrical properties, Seasonal variations, Carbonates, Calcium, Chlorine, Iron, Magnesium, Potassium, Sodium, Sulfates, Brazil, Nitrites, Ammonia.

The Jacare Pepira River Basin is part of Parana Basin which is the biggest hydrographic basin of South Brazil. It is located in the central part of Sao Paulo State in a region where the climate shows two seasons: warm and rainy (October-March) and cold and dry (April-September). A monthly study undertaken during two years (October 1978 - September 1980) showed that the Jacare Pepira River water quality can be defined by median values of electrical conductivity and ionic content distributed as 57.2 HCO3, 21.0 Si, 5.2 Ca, 4.7 Cl, 3.4 Fe, 2.5 Mg, 2.4 K, 2.0 Na, 1.0 N-NH3 and 0.3 N-NO3 (percentage based on mg/l data) (mg/l). The major ionic proportion showed the relation 42.0 Ca, 33.7 Mg, 14.3 Na and 9.7 K meq/l data to a total of 0.300 meq/l cations corresponding to 5.91 mg/l and 87.6 HCO3, 12.4 Cl (%) in meq/l to a total 0.525 meq/l anions (30.31 mg/l). Sulfate ions were undetectable with the method used. This paper discusses the relation between monovalent and divalent cations. (See also W88-09775) (Hammond-PTT)
W88-09776

LIMNOLOGICAL AND CLIMATOLOGICAL STUDY OF PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP, WITH THE INTENT TO POPULATE ITS RIVERS WITH THE RAINBOW TROUT, SALMO IRIDEUS GIBBONS (ESTUDO LIMNOLGICO E CLIMATICO DA REGIAO DO PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP, COM VISTAS AO POVOAMENTO COM TRUTA ARCO-IRIS, SALMO IRIDEUS GIBBONS),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
L. T. Schroeder-Araujo, H. L. Stempniewski, M. N. Cipolli, L. E. Santos, and M. Santo-Paulo.
Boletim do Instituto de Pesca, Vol. 13, No. 2, p 63-76, December 1986. 6 fig, 9 tab, 29 ref.

Descriptors: *Rivers, *Water quality, *Benthos, *Limnology, *Climatology, *Trout, Parque Estadual de Campos do Jordao, Growth, Benthic fauna, Benthic environment, Temperature, Precipitation, Physicochemical properties, Brazil, Parks.

The benthic community and some physical and chemical characteristics of the water of four rivers of the Parque Estadual de Campos do Jordao were studied. The investigations were conducted in five sections through monthly collections from March 1984 to February 1985 with the purpose of finding these characteristics and to supplementing the information needed to populate the rivers with rainbow trout (Salmo irideus). The density and the frequency of occurrence of benthic organisms for each month and season were established for each section. The results show that the Galharada, Canhambora and Casquilho streams have conditions for keeping trout fry; the Sapucai-Guacu stream is not favorable for the growth of this fish. The data on the temperature and rain suggest, according to Koeppen's classification, that the climate of the region is Cfb, i.e., a subtropical (temperate) altitude, mesothermic and humid, without drought and with the average temperature of the hottest month inferior to 22 C. (See also W88-09780) (Author's abstract)
W88-09779

USE OF MACROBENTHOS AS INDICATORS OF THE WATER QUALITY IN THE RIVERS OF PARQUE ESTADUAL DE CAMPOS DO

JORDAO, SP (ORGANISMOS BENTONICOS COMO INDICADORES DA QUALIDADE DA AGUA DE RIOS DO PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 5B.
W88-09780

MEASUREMENT OF BACTERIAL GROWTH RATES IN SUBSURFACE SEDIMENTS USING THE INCORPORATION OF TRITIATED THYMIDINE INTO DNA,
Dayton Univ., OH. Dept. of Biology.
For primary bibliographic entry see Field 7B.
W88-09790

MICROBIAL COMMUNITIES IN THE SATURATED GROUNDWATER ENVIRONMENT: II. DIVERSITY OF BACTERIAL COMMUNITIES IN A PLEISTOCENE SAND AQUIFER AND THEIR IN VITRO ACTIVITIES,
Bremen Univ. (Germany, F.R.).
For primary bibliographic entry see Field 2F.
W88-09792

PARTITIONING OF MANGANESE, IRON, ARSENIC, CADMIUM, LEAD, COPPER, ZINC, COBALT AND NICKEL IN SEDIMENTS FROM LAKE BIWA,
Okayama Univ., Kurashiki (Japan). Inst. for Agricultural and Biological Sciences.
For primary bibliographic entry see Field 5B.
W88-09801

DIAGENETIC BEHAVIORS OF HEAVY METALS AND NUTRIENTS IN ANOXIC SEDIMENT OF A FRESHWATER POND,
Central Research Inst. of Electric Power Industry, Tokyo (Japan).
M. Sakata.
Journal of Earth Science Nagoya University JEASAD, Vol. 35, No. 2, p 381-397, December 1987. 5 fig, 1 tab, 39 ref.

Descriptors: *Reservoirs, *Heavy metals, *Nutrients, *Diagenesis, *Sediments, Manganese, Iron, Copper, Lead, Zinc, Cadmium, Ammonium, Phosphate, Iron oxides, Manganese oxides, Interstitial water, Ponds, Seasonal variation, Japan.

The diagenetic behaviors of manganese, iron, copper, lead, zinc, cadmium, ammonium and phosphate in the anoxic sediment of a freshwater pond, T Reservoir, Japan, were examined using an in situ submerged chamber, through interstitial water and sediment analysis. Manganese and ammonium were released continuously from the sediment into the overlying water during the submerged chamber experiment, whereas iron and phosphate were released from the sediment abruptly after the second or third day of the experiment. The dissolution of ferro-manganese oxides and hydroxides at a sediment-water interface is important for the release of manganese, iron and phosphate from the sediment and the rapid remineralization of labile organic materials is important for the release of ammonium from the sediment. The bottom sediment is probably a more important source of manganese in T Reservoir during the summer when the overlying water becomes anoxic, than the input of total manganese (soluble and suspended) through river water. Copper and lead were not released from the sediment during the submerged chamber experiment, and their concentrations in the interstitial water were not significantly different from those in the overlying water. Copper and lead seem to be fixed into the sediment through a process other than the formation of sulfides. The sediment analyses also suggested that the diagenetic remobilization of zinc and cadmium in the sediment is negligibly small, similar to that of copper and lead. (Author's abstract)
W88-09802

LIMNOLOGY OF A SUBTROPICAL LAKE, BHIMTAL (U.P.), INDIA,
D.S.B. Constituent Coll., Naini Tal (India). Dept. of Zoology.
P. C. Sharma, and M. C. Pant.
Limnology (Berlin) LMNOA8, Vol. 18, No. 1, p 15-27, September 1987. 17 fig, 3 tab, 27 ref.

Descriptors: *Limnology, *Lakes, *Subtropical lakes, *Fish populations, *Phytoplankton, *Zooplankton, Physicochemical properties, Carp, Mesotrophic lakes, Transparency, Animal populations, Hydrogen ion concentration, Conductivity, Alkalinity, Dissolved oxygen, Nitrates, Animal populations, Phosphates, Hypolimnion, Eutrophication, Lake Bhimtal, India.

A year-round study was conducted of various physicochemical and biological variables of Lake Bhimtal. Climatically, the lake area tends to be subtropical in nature. The lake remained thermally stratified during summer and experienced a circulation period during winter. The moderate values of various physicochemical aspects such as transparency, pH, total alkalinity, electrical conductivity, NO3-N and PO4-P contents and low dissolved oxygen contents in the hypolimnion characterized the lake as a mesotrophic water body. Algal blooms were rarely present. The phytoplankton and zooplankton population showed an inverse relationship ($r = -0.76$) with each other. In terms of density, the ratio between the two was 1:8. The population size of both phyto- and zooplankton appeared to mainly controlled by fish grazers and Chaoborus. The lake supported a good population of carp fishes (herbivore and omnivore). Carnivorous fish were completely absent. (Sand-PTT)
W88-09805

PHYTOPLANKTON POPULATION DYNAMICS AND CHEMICAL CHARACTERISTICS OF THE SEDIMENTS OF THE SALIHIYAH RIVER, BASRAH, IRAQ,
University Coll., Cardiff (Wales). Dept. of Plant Science.
For primary bibliographic entry see Field 5C.
W88-09806

NATURAL AND COMPULSORY BIOLOGICAL DRIFT IN A SYSTEM OF MOUNTAIN STREAMS UNDER UREA TOP-DRESSING OF THE WATER CATCHMENT AREAS,
Bulgarian Academy of Sciences, Sofia.
For primary bibliographic entry see Field 5C.
W88-09807

COMPARATIVE PRIMARY PRODUCTION IN ONE POND AND RIVER SYSTEM AT BHAGALPUR, INDIA,
Bhagalpur Univ. (India). Post-Graduate Dept. of Botany and Zoology.
L. C. Saha, and B. Pandit.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 313-316, December 1987. 1 fig, 1 tab, 15 ref.

Descriptors: *Rivers, *Ponds, *Limnology, *Primary productivity, *Phytoplankton, *Macrophytes, *Eutrophication, Lentic environment, Lotic environment, Bhagalpur, India.

The primary production rate of two different systems (i.e. perennial pond and River Ganga at Bhagalpur) was investigated. Marked variation was obtained in the values of gross primary production, net primary production, community respiration and P/R ratio. Macrophytic production of the pond system was comparatively much higher than the river system. The degree of eutrophication is much more in lentic systems than lotic waterbodies. (Author's abstract)
W88-09808

AUTOCHTHONOUS CALCITE PRECIPITATION IN HARDWATER LAKES OF THE MECKLENBURG LAKE DISTRICT (AUTOCHTHONE KALKFALLUNG IN HARTWASSERSEEN DER MECKLENBURGER SEENPLATTE),
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
R. Koschel, G. Proft, and H. Raidt.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 317-338, December 1987. 11 fig, 9 tab, 76 ref.

Descriptors: *Limnology, *Mesotrophic lakes, *Oligotrophic lakes, *Eutrophic lakes, *Chemistry of precipitation, Deposition, *Calcium carbonate, Calcite, Primary productivity, Nutrients, Trophic level, Eutrophication, Mecklenburg Lake District, East Germany.

The spatial and temporal distribution of CaCO3, CO2, and Ca concentration were analyzed and related to primary production, nutrient concentration and trophic level in different stratified lakes of the Mecklenburg Lake District. Highest calcite precipitation and deposition were found in mesotrophic lakes, smallest in oligotrophic and highly eutrophic lakes. For example, the concentration of pelagic calcite (May to September; 0-5 m depth) averaged 0.45 g CaCO3/cu m in the mesotrophic Lake Breiter Luzin, 0.19 g CaCO3/cu m in the oligotrophic Lake Stechlin and 0.14 g CaCO3/cu m in the eutrophic Lake Dagow. From the observations and from scenario analysis with the ecological lake model SALMO the overall conclusion must be drawn that calcite precipitation and deposition is connected with coreactions which can play a fundamental role in the self-purification of lakes. Calcite precipitation leads to an increase of light transmission (light limitation of primary production), of co-precipitation of inorganic and organic dissolved nutrients (nutrient limitation of bioproduction) and of self-flocculation (elimination of particulate compounds). Calcite precipitation and deposition provides an autochthonous self-protection of carbonate-rich lakes against eutrophication. (Author's abstract)
W88-09809

LIMNOLOGY OF LAKE RINIHUE,
Universidad Austral de Chile, Valdivia. Inst. de Zoologia.
H. Campos, W. Steffen, G. Aguero, O. Parra, and L. Zuniga.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 339-357, December 1987. 11 fig, 8 tab, 26 ref. Direccion de Investigacion of Universidad Austral de Chile Grant S-83-49.

Descriptors: *Limnology, *Oligotrophic lakes, *Phytoplankton, *Zooplankton, *Primary productivity, Nutrients, Chlorophyll a, Nitrates, Phosphates, Seasonal variation, Vertical distribution, Turbulent flow, Stratification, Lake Rinihue, Chile.

Lake Rinihue is located in the Andean pre-mountain area at an altitude of 117 m. The lake has an area of 77.5 sq km and a maximum depth of 323 m. It is an oligotrophic temperate warm-monomictic lake. Its main physical and chemical factors were studied monthly for one year. The vertical distribution of phytoplankton was analyzed qualitatively and quantitatively, as well as the concentration of chlorophyll a, primary production and zooplankton abundance. The abiotic factors that best explain the biotic variations observed in the lake were assessed by factorial and step by step multiple regression analyses. The low inflow of nitrate and orthophosphates is responsible for the lake's oligotrophy. Other plant nutrients exhibit only small variations. The phytoplankton appears to be adapted to the oligotrophic conditions, with big cells which can remain suspended in the water due to high water turbulence and that are capable of capturing low concentrations of nutrients under the turbulent conditions. During lake stratification the phytoplankton shows a low diversity with the dominance of a few species, Melosira hustedtii being the most important. The concentrations of chlorophyll are not closely related to assimilation rates over the course of the year. The primary productivity is low with maxima in early summer (December). The zooplankton shows several maxima, the highest one occurring in autumn, and a marked succession of species. (Author's abstract)
W88-09810

DISSOLVED OXYGEN REGIMES AND THE LEVEL OF EUTROPHICATION IN SURIN-

SAR, A SUB-TROPICAL FRESHWATER LAKE IN JAMMU, INDIA,
Punjab Agricultural Univ., Ludhiana (India). Dept. of Zoology.
H. S. Sehgal, and M. K. Jyoti.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 359-364, December 1987. 5 fig, 20 ref.

Descriptors: *Limnology, *Eutrophic lakes, *Dissolved oxygen, Seasonal variation, Macrophytes, Biomass, Subtropic zone, Limnetic zone, Littoral zone, Thermal stratification, Lake Surinsar, India.

Seasonal fluctuations in dissolved oxygen (DO) at surface and sub-surface layers of Lake Surinsar from October 1976 to September 1978, and the use of DO in characterizing the trophic state of the lake are presented. DO remains slightly higher at the limnetic than at the littoral zone, yet the pattern of seasonal fluctuation is similar at both zones. The maximum DO in surface layers in October is due to maximum biomass of aquatic macrophytes whereas the minimum in January is due to mixing of oxygen deficient bottom layers of the lake with surface and death and decay of aquatic vegetation. There are well marked DO changes from surface to bottom. A decline in DO in deeper layers resulting in a clinograde DO curve during thermal stratification and other limnological characteristics of Lake Surinsar suggest it to be a eutrophic lake. (Author's abstract)
W88-09811

VEGETATION OF AGRICULTURAL RESERVOIRS IN THURINGIAN BROOKS (ZUR VEGETATION LANDWIRTSCHAFTLICHER WASSERSPEICHER IM THURINGER BECKEN),
Akademie der Landwirtschaftswissenschaften der DDR, Halle/Saale. Inst. fuer Landschaftsforschung und Naturschutz.
W. Westhus.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 381-403, December 1987. 7 fig, 10 tab, 54 ref.

Descriptors: *Reservoirs, *Agriculture, *Streams, *Vegetation, *Aquatic ecosystems, Water level fluctuations, Carp, Fisheries, Eutrophication, Succession.

The vegetation of agricultural water reservoirs and itazonation are described with special reference to the effects of utilization, e.g. water level fluctuations, intensive carp rearing and eutrophication. Special emphasis is on the succession and annual dynamics of the shore vegetation. (Author's abstract)
W88-09812

BACTERIAL ASSIMILATION OF DISSOLVED AND PARTICULATE PHYTOSYNTHESIS PRODUCTS (BAKTERIELLE NUTZUNG VON GELOSTEN UND PARTIKULAREN PHOTOSYNTHESEPRODUKTEN),
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
C. Babenzien.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 409-422, December 1987. 4 fig, 7 tab, 50 ref.

Descriptors: *Limnology, *Oligotrophic lakes, *Eutrophic lakes, *Bacteria, *Algae, *Phytoplankton, *Primary productivity, Carbon dioxide, Carbon radioisotopes, Mineralization, Metabolism, Organic compounds, Organic carbon, Photosynthesis, Lake Stechlin, Lake Dagow, Germany.

Microheterotrophic use of photoassimilated compounds was studied in two lakes of the Lake Stechlin area in the summer months. Primary production, exudation and bacterial assimilation of exudates were measured with the carbon-14 method and a particle size fractionation technique. Production of carbon-14 CO2 was employed as an estimate of the mineralization of carbon-14 labeled particulate photoassimilated matter. Methodological aspects for a preferential application of natural mixed substrates for estimation of in situ bacterial activities are discussed. In investigations with natural phytoplankton populations average exudation rates of 50% in the oligotrophic Lake Stechlin and 20% in the eutrophic Lake Dagow were obtained. A distinct part of the released substances was assimilated by the bacterial population, an average 20% and 8% of the primary production in the two lakes. Regarding the degradation of particulate phytoplankton, mineralization rates of about 5% per day were obtained in both lakes. These results confirm the previously published reports of the significance of organic substances released during primary production as carbon sources for planktonic bacteria and the close coupling between algal and bacterial metabolism. (Author's abstract)
W88-09813

EFFECT OF TERRESTRIAL LITTER ON THE MATERIAL BUDGET OF OLIGOTROPHIC WATERS (STRECHLIN LAKE) (BEDEUTUNG VON TERRESTRISCHEM PFLANZENMATERIAL FUR DEN STOFFHAUSHALT EINES OLIGOTROPHEN GEWASSERS (STECHLINSEE)),
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
P. Casper.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 423-430, December 1987. 2 fig, 5 tab, 29 ref.

Descriptors: *Limnology, *Macrophytes, *Litter, *Decomposition, Beech trees, Littoral zone, Sedimentation rates, Primary productivity, Lake Stechlin, Germany.

The transport of litter into Lake Stechlin during autumn 1985 was 1111 g C/m of shoreline (total: 38.7 t plant material). About 60% of this material were beech leaves (Fagus sylvatica). The carbon and nitrogen content of beech leaves were estimated as 46.4 and 2.1% of dry weight. This means an increase of 4.2 g C/sq m/a. Airborne litterfall amounted to 4.4% of the pelagic primary production. The decomposition rate of beech leaves in Lake Stechlin was 0.0011/d. This rate was not dependent on the trophic level of water, on temperature regime or on biocoenosis. On the basis of the assumption that leaves were decomposed in the littoral region it was calculated that the sedimentation rate increases to 152 mg C/sq m/d. If the decomposition of macrophytes is taken into account, the sedimentation rate in littoral regions increases to about 250 mg C/sq m/d. (Author's abstract)
W88-09814

ASSESSING BIOTIC INTEGRITY OF THE FISH COMMUNITY IN A SMALL ILLINOIS STREAM,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 7B.
W88-09818

EFFECTS OF VARIABLE STREAMFLOWS ON GROWTH OF SMALLMOUTH BASS IN THE MAQUOKETA RIVER, IOWA,
Iowa Dept. of Natural Resources, Manchester. Northeast District Headquarters.
For primary bibliographic entry see Field 8I.
W88-09821

USE OF ZOOPLANKTON SIZE TO ASSESS THE COMMUNITY STRUCTURE OF FISH POPULATIONS IN FRESHWATER LAKES,
Cornell Univ., Ithaca, NY. Dept. of Natural Resources.
For primary bibliographic entry see Field 8I.
W88-09822

CORRELATIONS OF REGULATED LAKE LEVELS AND CLIMATIC FACTORS WITH ABUNDANCE OF YOUNG-OF-THE-YEAR WALLEYE AND YELLOW PERCH IN FOUR LAKES IN VOYAGEURS NATIONAL PARK,
Voyageurs National Park, International Falls, MN.
For primary bibliographic entry see Field 8I.
W88-09825

EFFECTS OF STOCKING HYBRID STRIPED BASS IN SPRING LAKE, ILLINOIS,
Western Illinois Univ., Macomb. Dept. of Biological Sciences.
L. A. Jahn, D. R. Douglas, M. J. Terhaar, and G. W. Kruse.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 4, p 522-530, Fall 1987. 5 tab, 21 ref. Federal Aid in Fish Restoration Project F-39-R.

Descriptors: *Lake fisheries, *Fish management, *Fish stocking, *Spillways, Fish populations, Bass, Shad, Crappie, Catfish, Fish food organisms, Seasonal variation, Growth, Spring Lake, Illinois.

Spring Lake, a 101-hectare impoundment that supplies potable water to Macomb, Illinois, was stocked with hybrid striped bass (striped bass Morone saxatilis x white bass M. chrysops) from 1980 through 1985 at rates of 20-30 fish/hectare. Fish from the 1982 stocking reached the 432-mm minimum legal length in 28 months. Fish stocked when they were 20 mm long in June grew better and had higher survival rates than those stocked at larger sizes or later in the summer. Hybrid striped bass ate primarily gizzard shad Dorosoma cepedianum. Adult largemouth bass Micropterus salmoides, white crappies Pomoxis annularis, and channel catfish Ictalurus punctatus also relied heavily on gizzard shad, whereas juveniles fed mainly on invertebrates. Only white crappies showed any major seasonal change in food habits. By the end of 1985, white crappies were attaining a length of 200 mm 1 year earlier than in 1980. Numbers of white crappies and average sizes increased while fishing pressure and catches of other target species remained relatively unchanged. Some spillway loss of hybrids occurred. (Author's abstract)
W88-09826

TRITIUM HYDROLOGIC STUDIES IN FOUR CLOSED-BASIN LAKES IN THE GREAT BASIN, U.S.A.,
Lamont-Doherty Geological Observatory, Palisades, NY.
For primary bibliographic entry see Field 7B.
W88-09843

ALKALINITY AND MAJOR ION BUDGETS FOR A MASSACHUSETTS RESERVOIR AND WATERSHED,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W88-09844

AMMONIUM AND PHOSPHATE UPTAKE RATES, N:P SUPPLY RATIOS, AND EVIDENCE FOR N AND P LIMITATION IN SOME OLIGOTROPHIC LAKES,
British Columbia Univ., Vancouver. Dept. of Botany.
C. A. Suttle, and P. J. Harrison.
Limnology and Oceanography LIOCAH, Vol. 33, No. 2, p 186-202, March 1988. 5 fig, 7 tab, 75 ref. Fisheries and Oceans, Canada, Science Subvention Grant 65-1849 and NSERC of Canada Grant 67-0128.

Descriptors: *Cycling nutrients, *Lakes, *Ammonium, *Phosphates, *Limiting nutrients, Chemical properties, Oligotrophic lakes, Absorption, Phytoplankton, Cultures, Continuous culture, Species composition, Algae, Cyanophyta, Chrysophyta, Diatoms, Nitzschia, Chlorophyta, Scenedesmus.

Natural assemblages of freshwater phytoplankton were grown in daily-dilution culture (0.50/d) at six N:P supply ratios (5:1, 10:1, 15:1, 25:1, and 45:1; by atoms), to create a range of N- and P-limited conditions. After a minimum of 30 d in culture, subsamples were removed for determination of saturated phosphate and ammonium uptake rates. A relationship was found between the ratio of phosphate-to-ammonium uptake rates and N:P supply ratio, indicating that this index was sensitive to the N:P supply ratio under which phyto-

plankton are grown. Community composition in the 5:1, 15:1, and 45:1 treatments was influenced by supply ratio. Cultures grown at the highest ratio were dominated by a chroococcoid cyanobacterium (probably Synechococcus sp.), while those grown at the two lower ratios were dominated by the diatoms Nitzschia and Synedra and the chlorophyte Scenedesmus. Saturated ammonium and phosphate uptake rates were determined for Synechococcus and Synedra, grown under different N:P supply ratios. The good competitor for P (Synechococcus) demonstrated a low capacity for ammonium uptake under N-limited conditions, while the good competitor for N (Synedra) showed poor ability to sequester phosphate under P-limited conditions. Additional experiments were conducted on two oligotrophic lakes in an effort to determine if N and P co-occurred as limiting resources. Nutrient bioassay studies on water from one of these lakes indicated that N was in short supply among members of the phytoplankton community. Estimates of in situ N:P supply ratios in the lakes ranged from 18:1 to >45:1, as well. Results of these experiments were consistent with limitation by N and P at times. (Author's abstract)
W88-09845

DISCOVERIES AND TESTABLE HYPOTHESES ARISING FROM COASTAL ZONE COLOR SCANNER IMAGERY OF SOUTHERN LAKE MICHIGAN,
Wisconsin Univ., Milwaukee. Center for Great Lakes Studies.
C. H. Mortimer.
Limnology and Oceanography LIOCAH, Vol. 33, No. 2, p 203-226, March 1988. 13 fig, 1 tab, 41 ref. NASA Grant NAG 5-209 SI and NOAA Grant NA 81 RA C00130.

Descriptors: *Lakes, *Limnology, *Remote sensing, *Satellite technology, Lake Michigan, Synoptic analysis, Theoretical analysis, Water temperature, Phytoplankton, Sediment transport, Dissolved solids, Upwelling, Sediment-water interfaces, Aquatic fronts, Hydrodynamics.

CZCS (Coastal Zone Color Scanner) images, confined mainly to the southern basin of Lake Michigan during the warm-up phases of 1979, 1980, and 1981, have furnished tools for synoptic reconnaissance of the wind-perturbed transition of the thermal regime in large basins from the winter to summer condition (including front formation and upwelling events), the coupling of phytoplankton growth with that transition, the intermittent mobilization and surface transport of sediment resuspended by storms, and the extensive temporary trapping of river-derived dissolved organic matter (gelbstoff) between the shoreline and the offshore-migrating thermal front. Intermittent resuspension of particles and variable inputs of gelbstoff, which occur in many coastal waters, render inapplicable the CZCS algorithms successfully used in ocean studies for atmospheric correction and for quantification of phytoplankton chlorophyll. That disappointment notwithstanding, there is a favorable match of the coverage and scene-revisit frequency of the CZCS and the space and time scales of significant features of the above-listed processes. The observed pattern changes shed new light on the above processes and generate several testable conjectures. These relate to whole-basin sediment transport, coastal upwelling of near-bottom sediment suspensions, and frontal hydrodynamics and its coupling with phytoplankton distributions. (Author's abstract)
W88-09846

MACROFAUNA AND ENVIRONMENT OF THE NANPIL-KIEPW RIVER, PONAPE, EASTERN CAROLINE ISLANDS,
Seattle National Fishery Research Center, WA.
J. A. Maciolek, and J. I. Ford.
Bulletin of Marine Science, Vol. 41, No. 2, p 623-632, September 1987. 2 fig, 4 tab, 14 ref.

Descriptors: *Islands, *River flow, *Aquatic animals, *Aquatic habitats, *Limnology, Species composition, Population dynamics, Taxonomy, Fish, Caroline Islands, Crustaceans, Aquatic insects, Comparison studies, Species diversity, Nanpil-Kiepw River, Samoa, Guam, Hawaii, Ponape, Palau.

The first comprehensive evaluation of stream fauna in the Eastern Caroline Islands resulted from collections on Ponape, a 334-sq km island having more than 40 streams, many of which arise along 700-m-high interior ridges. Field surveys centered on the Nanpil-Kiepw River below 170 m elevation, a bouldery reach with water of low mineral content and frequent surging flows. Faunal specimens were collected by electrofishing, rotenone treatment, netting, and hand picking. Discharge character of the Nanpil-Kiepw River is similar to but more extreme than that of other streams of Oceania with which it was compared. Drastic flow surges appeared to be a major factor affecting community structure. At least 44 faunal species were present, 36 of them representing taxons primarily of marine origin that are characteristic of oceanic islands: 15 fishes (5 families), 10 decapod crustaceans (3 families), and 11 snails (2 families). Larvae of aquatic moths were the only insects of significance. Four sicyldiine gobies are new species possible endemic to Ponape or the Eastern Caroline Islands. Based on numbers of species within prominent taxons and diadromous groups, Ponape's faunal diversity exceeds that of Samoa, Guam, and Hawaii, but is lower than that of Palau. Similarities of Ponape's identified fish species to those of Palau suggest that Ponape was colonized from the west along the 'Caroline conduit.' (Author's abstract)
W88-09859

MAN AND MIRE: A LONG AND WET RELATIONSHIP,
King's Coll., London (England). Dept. of Biology.
For primary bibliographic entry see Field 4C.
W88-09860

HYPHOMYCETES IN THE RIVER KELVIN,
Glasgow Univ. (Scotland). Dept. of Botany.
Y. Galloway, and C. G. Elliott.
Transactions of the Botanical Society of Edinburgh, Vol. 45, No. 2, p 141-148, 1988. 2 fig, 4 tab, 13 ref.

Descriptors: *Rivers, *Aquatic fungi, *Hyphomycetes, *Spores, *Limnology, *Species composition, *Aquatic plants, *Aquatic habitats, Seasonal variation, Vegetation, River Kelvin, Scotland, Detritus.

The hypohmycete spora of the River Kelvin and its tributary, the Allander Water, was sampled during October 1986 to January 1987. Twenty spore types were found, the commonest being Flagellospora curvula and Lemonniera aquatica. Spore numbers were high in October and declined during the autumn to an undetectable level by the end of December, but leaves collected in December and January yielded spores on incubation in water. (Author's abstract)
W88-09861

HYPHOMYCETES IN THE STREAM AT THE ROYAL BOTANIC GARDEN, EDINBURGH AND NOTES ON THEIR DISTRIBUTION IN SCOTLAND,
Royal Botanic Garden, Edinburgh (Scotland).
R. Hollands, and R. Watling.
Transactions of the Botanical Society of Edinburgh, Vol. 45, No. 2, p 149-155, 1988. 4 fig, 1 tab, 17 ref.

Descriptors: *Aquatic fungi, *Hyphomycetes, *Spores, *Limnology, *Species composition, *Spatial distribution, Seasonal variation, Vegetation, Streams, Scotland, Comparison studies, Botanic gardens.

The hyphomycete spora of the stream in the Rock Garden of the Royal Botanic Garden, Edinburgh, was samples during the winter of 1983/84. Eighteen species were found, the three most common being Anguillospora pseudolongissima, Tetracladium setigerum and Anguillospora longissima. The spores were most numerous in December and although still present in February and March had decreased quite considerably in number. Comparisons are made between the samples and also with other similar studies conducted elsewhere. (Author's abstract)
W88-09862

TIDAL INFLUENCE ON THE WETLAND COMMUNITY STRUCTURE BEHIND THE DIKE ALONG THE ELBE ESTUARY,
Hamburg Univ. (Germany, F.R.). Inst. fuer Hydrobiologie und Fischereiwissenschaft.
C. W. Heckman.
Archiv fuer Hydrobiologie, Supplement Vol. 75, AHBSA8, No. 1, p 1-117, October 1986. 12 fig, 14 tab, 57 ref.

Descriptors: *Wetlands, *Dikes, *Elbe Estuary, *Tidal effects, *Species composition, *Population dynamics, Cycling nutrients, Physical properties, Sediment transport, Estuaries, Coastal water, Biomass, Aquatic habitats.

An investigation of the physical, chemical, and biological features of wetlands along the freahwater section of the Elbe Estuary revealed that the typical biotic community of the estuarine habitat can survive behind a dike in the vicinity of large flood gates that allow the free passage of the tidal currents. Nevertheless, the presence of the dikes has permitted the wetlands to be extensively drained and modified for intensive agriculture, bringing about thoroughgoing changes in the flora and fauna. A consideration of the ecological roles of > 1000 species present revealed an obvious displacement of the lotic water and marshland species by those typical of lentic or terrestrial habitats. Although the estuarine biota still survives in and beside a few ditches, the basic character of most of the wetland has been substantially changed, in spite of the open flood gates. The dike has also interrupted the transport of dissolved and particulate matter, including nutrients, from the water of the estuary to the soil of the flood plain, a process that formerly cleansed the Elbe and enriched the alluvial soil. (Author's abstract)
W88-09875

LIMNOLOGY OF A WETLAND COMPLEX IN THE MISSISSIPPI ALLUVIAL VALLEY OF SOUTHEAST MISSOURI,
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
G. D. Wylie, and J. R. Jones.
Archiv fuer Hydrobiologie, Supplement Vol. 74, AHBSA8, No. 3, p 288-314, December 1986. 7 fig, 6 tab, 92 ref.

Descriptors: *Reservoirs, *Forests, *Flooding, *Wetlands, *Missouri, *Limnology, Cycling nutrients, Seasonal variation, Biomass, Limiting nutrients, Macrophytes, Phytoplankton, Aquatic plants, Aquatic habitats, Zooplankton, Salinity, Litter, Leachate, Duckweed.

Productive wetlands in southeast Missouri, characterized by low salinity, were studied from 1981-1983. Nutrient chemistry was related to water level management of individual sites. A permanently flooded reservoir had the lowest nutrient concentrations, periodically drained marsh sites contained moderate nutrient levels, and autumnally-flooded forest sites had the highest nutrient concentrations derived from leachate of leaf litter. Nutrient concentrations in the forested sites reached maximum values within a few months after inundation and decreased thereafter. Algal biomass was typically nitrogen-limited in the sites, but high macrophyte production in the largest sites did not depend on nutrients in the water. In addition, rates of community metabolism were related to relative dominance of phytoplankton, rooted macrophytes or duckweeds in the respective sites rather than to nutrient content of the water. Zooplankton concentrations in managed forested sites increased and decreased over time patterns similar to changes in nutrient concentrations, which, together with results from other investigations, suggests that detritivore production in temporarily flooded forest is initially high and subsequently decreases with duration of flooding. (Author's abstract)

W88-09877

BENTHIC ECOLOGY OF RIVERS IN THE BLUE MOUNTAINS (JAMAICA) PRIOR TO CONSTRUCTION OF A WATER REGULATION SCHEME,
Newcastle upon Tyne Univ. (England). Dept. of Zoology.
For primary bibliographic entry see Field 6G.
W88-09878

INTERSTITIAL FAUNAL COMMUNITIES OF THE HYPORHEIC AND ADJACENT GROUNDWATER BIOTOPES OF A COLORADO MOUNTAIN STREAM,
Colorado Univ. at Boulder.
R. W. Pennak, and J. V. Ward.
Archiv fuer Hydrobiologie, Supplemetn Vol. 74, AHBSA8, No. 3, p 356-396, December 1986. 11 fig, 19 tab, 71 ref.

Descriptors: *Streams, *Groundwater, *Colorado, *Interstitial fauna, *Species composition, *Limnology, Biotopes, Population dynamics, Aquatic habitats, Macroinvertebrates, Mountains, Crustaceans, Aquatic insects, Physicochemical properties.

Interstitial fauna and physicochemical data were collected year-round to depths of 50 cm from the hyporheic, shoreline, and phreatic biotopes of a Colorado mountain stream. Physical and chemical conditions were, with few exceptions, remarkably similar to the stream itself. Crustaceans, insects, archiannelids, and oligochaetes were the predominant faunal components. Harpacticoid copepods occurred at high densities in all biotopes; cyclopoids were less abundant. Bathynella was found only in shoreline and phreatic samples. Ostracods were rare. Total interstitial crustacean populations were much more dense than are planktonic crustaceans in lakes of the region. A diverse chironomid fauna included some distinct interstitial forms. The archiannelid Troglochaetus was most abundant in the shore zone. Oligochaetes were most abundant in the hyporheic waters. Acarina were rare except for Soldanellonyx. Several groups, including isopods, tardigrades, and rotifers, were conspicuously absent. Although there is considerable faunal overlap, each biotope has some distinctive features. Based solely on relative abundance, the following assemblages are apparent: a Phyllognathopus/Bryocamptus/Microcyclops hyporheic community; a Phyllognathopus/Bryocamptus/Troglochaetus shore community; and a Phyllognathopus/Bathynella/Microcyclops phreatic community. Seasonal population trends and faunal depth distribution patterns are also examined. (Author's abstract)
W88-09879

LEAF LITTER PROCESSING IN COASTAL PLAIN STREAMS AND FLOODPLAINS OF SOUTHEASTERN GEORGIA, U.S.A.,
Georgia Univ., Athens. Dept. of Entomology.
T. F. Cuffney, and J. B. Wallace.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 1/2, p 1-24, June 1987. 9 fig, 4 tab, 43 ref. NSF Grant DEB-8104427.

Descriptors: *Streams, *Leaf litter processing, *Flood plains, *Georgia, *Macroinvertebrates, *Limnology, *Model studies, Aquatic habitats, Cycling nutrients, Species composition, Population dynamics, Dissolved oxygen, Fate of pollutants, Path of pollutants, Litter.

Leaf litter processing rates and the macroinvertebrate communities associated with leaf litter were studied in river and floodplain habitats of two Georgia Coastal Plain streams, the Ogeechee River and Black Creek. Study habitats were chosen to give information on the effects of periodic flooding and water velocity on decomposition rates and community structure. Rates of sweetgum and water oak leaf litter procession were calculated from 9 models which incorporated information on time, temperature, and degree of flooding. Sweetgum processed significantly faster than water oak in all locations. Processing rates were faster in river sites than in floodplain ponds which were very shallow, full of organic matter, and had low oxygen contents. Floodplain high and low habitats had comparable processing rates which did not vary significantly among floodplains. Leaf litter processing rates from all sites were very slow when compared to headwater streams. Nitrogen content, initially higher in water oak than in sweetgum increased through time for both species in all habitats. Aquatic sites generally had higher bacterial densities than did seasonally flooded sites. Macroinvertebrate communities associated with leaf litter bags were dominated by collector-gatherers and contained very few insect shredders. Only 5 of the 74 insect taxa collected from leaf bags were shredders. Non-insect macroinvertebrates were much more abundant. These floodplain habitats represent disturbed systems by virtue of their large fluctuations in water level, temperature, discharge, and dissolved oxygen. Due to these disturbances, Coastal Plain river-floodplain systems can not establish terrestrial or aquatic communities which can effectively process the large amounts of detritus which fall on the floodplain each year. (Alexander-PTT)
W88-09880

EFFECTS OF SEASONAL AND HYDROLOGICAL INFLUENCES ON THE MACROINVERTEBRATES OF THE RHONE RIVER, FRANCE: II. ECOLOGICAL ASPECTS,
Lyon-1 Univ., Villeurbanne (France). Section of Freshwater Ecology.
M. Bournaud, H. Tachet, and A. L. Roux.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 1/2, p 25-51, June 1987. 15 fig, 3 tab, 52 ref.

Descriptors: *Reservoirs, *Rhone River, *Seasonal variation, *Macroinvertebrates, *Limnology, *Species composition, Ecological effects, Population dynamics, Aquatic animals, Aquatic habitats, Rivers, France, Flushing, Hydrologic properties.

The ecological ramifications of seasonal and hydrological influences on macroinvertebrates of the Rhone River (France) are discussed. The taxa are classified according to the correlation with different time scales of discharge (spates and tendancy discharge) and seasonal variables (day length and water temperature). The influence of the flush-out of an upstream reservoir was also examined. The predominance of hydrological variables is the most important factor that determines the functional characteristics of the species groups. The fauna are linked to flow rate variations and to the time scale of these variations. (Author's abstract)
W88-09881

REED DECAY AT LAKE CONSTANCE (UNTERSEE) OBSERVATIONS AND INVESTIGATIONS (DAS SCHILFSTERBEN AM BODENSEE - UNTERSEE BEOBACHTUNGEN, UNTERSUCHUNGEN UND GEGENMASSNAHMEN),
For primary bibliographic entry see Field 5C.
W88-09882

FUNGAL PARASITISM OF PLANKTONIC ALGAE IN SHEARWATER: I. OCCURRENCE OF ZYGORHIZIDIUM AFFLUENS CANTER ON ASTERIONELLA FORMOSA HASS. IN RELATION TO THE SEASONAL PERIODICITY OF THE ALGA,
Firat Univ., Elazig (Turkey). Dept. of Biology.
B. Sen.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 1/2, p 101-127, June 1987. 14 fig, 1 tab, 37 ref.

Descriptors: *Fungi, *Algae, *Parasitism, *Seasonal variation, *Limnology, *Temperature effects, Diatoms, Shearwater Lake, Aquatic plants, Aquatic habitats, Population dynamics, Epidemics.

The seasonal periodicity of Asterionella formosa Hass. in Shearwater Lake in Wiltshire, England was studied for three years paying particular attention to the occurrence of the chytrid Zygorhizidium affluens Canter on the diatom and to the effect of parasitism on the seasonal cycle. Most of the planktonic algae are infected by fungi but parasitic infection was the heaviest on A. formosa. Three major epidemics occurred during the vernal development of Asterionella lasting for two months on each occasion. Occurrence of epidemics of Z. affluens was unpredictable but coincided with high Asterionella numbers. Chytrids could occur any time of the year and temperature seems to be the only factor affecting the occurrence of epidemics. The occurrence of epidemics generally coincided with very cold periods. The effects of the remaining physical-chemical factors are obscure. The degree of infection depends on the relative growth rate of both host and parasite. The highest infection rate was 63%. A frustule size of Asterionella from 49 microns to 57 microns was most susceptible to fungal attack whatever the host population size. Average number of cells per Asterionella colony did not show a definite correlation with epidemics. Ratio of dead cells to live cells increases during epidemics. Restriction on the rate of increase of Asterionella appears to be related to the degree of fungal infection of the population. Decline of Asterionella during severe epidemics favored the growth of other diatoms. It is concluded that parasitism is clearly one of the factors responsible for the decline in the numbers of Asterionella. However, the epidemics did not eliminate the Asterionella population. Asterionella increased after the most severe epidemics. Fungal epidemics did not alter the normal seasonal periodicity of the alga. (See also W88-09884) (Author's abstract)
W88-09883

FUNGAL PARASITISM OF PLANKTONIC ALGAE IN SHEARWATER: II. A STUDY OF THE CHYTRID PARASITES OF THE DIATOM FRAGILARIA CROTONENSIS KITTON,
Firat Univ., Elazig (Turkey). Dept. of Biology.
B. Sen.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 1/2, p 129-144, June 1987. 7 fig, 1 tab, 13 ref.

Descriptors: *Fungi, *Algae, *Parasitism, *Seasonal variation, *Limnology, *Population dynamics, Diatoms, Shearwater Lake, Aquatic plants, Aquatic habitats, Ecological effects, Epidemics.

Parasitism of Fragilaria crotonensis Kitton was studied for three years in Shearwater Lake, Wiltshire, England. F. crotonensis was represented only by rod-type filaments which may possibly be infected by two morphologically similar chytrids: Rhizophydium fragilariae Canter and species 3. The occurrence of epidemics was irregular and usually coincided with the periods of active growth of the diatom. However, at one stage an epidemic was synchronous with a declining host population. No single or group of factors could be demonstrated to explain the occurrence of the epidemics. During the longest and the most severe epidemic, development of a second attack indicated that the development of chytrids can continue stage after stage for a long time if the conditions are favorable. Fungal infections consisted mainly of encysted zoospores and mature sporangia. At least 50 fils./ml. of Fragilaria appears to be a requirement for the fungus to reach epidemic proportions. Epidemics usually behan with high numbers of mature sporangia and the most severe epidemic was characterized by large numbers of resting spores. Empty sporangia were found during only the most severe and the longest epidemic. Highest infection rate was 55%. Distinct frustule lengths of Fragilaria were present and some were infected more than others. The effects of parasitism on the numbers of Fragilaria remained obscure. The occurrence of parasitism did not noticeably affect the population growth pattern of the diatom. Ratio of dead cells to live cells increased during all the epidemics. The autumn maximum of Fragilaria was later and smaller in size during an epidemic than at other times when infections were not present. (See also W88-09883) (Author's abstract)
W88-09884

LIMNOLOGICAL FEATURES OF A PUERTO RICAN RESERVOIR,

Center for Energy and Environment Research, Mayaguez, PR.
L. J. Tilly, and J. R. Garcia-Sais.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 1/2, p 145-167, June 1987. 13 fig, 3 tab, 54 ref.

Descriptors: *Rainfall, *Puerto Rico, *Reservoirs, *Lake La Plata, *Eutrophication, *Limnology, *Seasonal variation, *Limiting nutrients, Primary productivity, Phytoplankton, Macrophytes, Algae, Lakes, Weather data collections, Hydrology, Thermal stratification, Storms, Tropical regions.

Lake La Plata in northeastern Puerto Rico was sampled for a period of one year and data collected were used in combination with historical meteorological data to develop a generalized idea of how this tropical reservoir normally functions. Although the lake is basically warm monomictic the combination of a hydrology characterized by weak seasonality and relatively high rainfall and a mountainous topography providing wind protection results in the development of a pattern in which storm events may dictate the structure of the reservoir at virtually any time of year. The lake is usually thermally stratified and shows a strong oxycline. The vertical and horizontal nutrient distribution reflects heavy tributary loading, high metabolic rates and nitrogen limitation. Overall, the system appears to be converting high nutrient loads into primary production without developing bloom concentrations of algae. Upstream, respiration and assimilation are apparently high and phytoplankton activities account for the metabolism of the system; downstream, the reservoir is dominated by the macrophyte, Eichornia crassipes. La Plata presents a good opportunity to study the interactions of macrophytes and phytoplankton in a tropical ecosystem. (Author's abstract)
W88-09885

MACROZOOBENTHOS OF STRUMA RIVER: AN EXAMPLE OF A RECOVERED COMMUNITY AFTER THE ELIMINATION OF A HEAVY INDUSTRIAL IMPACT WITH SUSPENDED MATERIALS,

Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
For primary bibliographic entry see Field 5G.
W88-09886

AQUATIC MACROPHYTES IN SHOAL LAKE (MANITOBA - ONTARIO): I. DIVERSITY, BIOMASS AND METABOLIC STATUS IN RELATION TO WATER DEPTH AND LIGHT INTENSITY,

Winnipeg Univ. (Manitoba). Dept. of Biology.
E. Pip, and C. Sutherland-Guy.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 3, p 197-222, July 1987. 10 fig, 9 tab, 35 ref.

Descriptors: *Shoal Lake, *Limnology, *Macrophytes, *Light quality, *Species composition, *Population dynamics, Biomass, Seasonal variation, Chlorophyll a, Statistical methods, Carbohydrates, Lakes, Manitoba, Canada.

Submerged aquatic macrophyte communities were studied over a depth range of 14 m in Shoal Lake, Manitoba, on the Precambrian Shield, where temperature stratification was not pronounced. Light was a major factor influencing community diversity and biomass. Chlorophyll content of Potamogeton foliosus, P. zosteriformis, Elodea canadensis, Najas flexilis, Myriophyllum exalbescens and Ceratophyllum demersum was variable, but significant positive correlations were found between water depth and chlorophyll a and total chlorophyll content for at least part of the season for all species except P. foliosus. Chlorophyll a:b ratios showed inconsistent trends with water depth for different species and times. Soluble protein content showed some significant positive correlations with depth. Only one negative correlation was found between depth and soluble protein:total chlorophyll ratios. Soluble carbohydrate content was positively associated with depth in some instances, and negatively or not at all in others. Soluble carbohydrate:total chlorophyll ratios were strongly negatively correlated with depth for several species. Other factors besides light were probably also operating to influence chlorophyll, soluble protein and soluble carbohydrate content of macrophytes in the study area. (See also W88-09888) (Author's abstract)
W88-09887

AQUATIC MACROPHYTES IN SHOAL LAKE (MANITOBA - ONTARIO): II. SEASONAL AND LOCAL CHLOROPHYLL CONCENTRATIONS IN RELATION TO TEMPERATURE AND WATER CHEMISTRY,

Winnipeg Univ. (Manitoba). Dept. of Biology.
E. Pip.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 3, p 223-235, July 1987. 1 fig, 3 tab, 24 ref.

Descriptors: *Shoal Lake, *Limnology, *Macrophytes, *Biomass, *Species composition, *Temperature effects, *Water chemistry, Seasonal variation, Chlorophyll a, Hydrogen ion concentration, Limiting nutrients, Statistical methods, Lakes, Chemical properties, Alkalinity, Phosphorus, Nitrogen, Manitoba, Canada.

Seasonal and local chlorophyll content was examined in Potamogeton foliosus, P. zosteriformis, Elodea canadensis, Myriophyllum exalbescens and Ceratophyllum demersum with respect to temperature and eight water chemistry parameters in Shoal Lake. Chlorophyll content increased significantly with time in E. canadensis and C. demersum, and decreased in P. foliosus. Chlorophyll content was significantly positively correlated with seasonal temperatures in E. canadensis, C. demersum and P. zosteriformis, and negatively correlated in P. foliosus. Of the water chemistry parameters examined, pH, total alkalinity, inorganic phosphorus and total inorganic nitrogen were correlated with chlorophyll content, but only in some species. Stepwise multiple regression analysis identified the major parameters that appeared to be related to chlorophyll content for each species. Seasonal and local chlorophyll a:b ratios were correlated with identifiable parameters only for E. canadensis and P. foliosus. The results underline the differences which exist between macrophyte species with respect to metabolism in natural environments and suggest that many factors probably act together to influence chlorophyll concentrations in different macrophytes. (See also W88-09887) (Author's abstract)
W88-09888

CYCLOPOID COPEPODS IN MARGINAL HABITATS: ABIOTIC CONTROL OF POPULATION DENSITIES IN ANTHROPOGENIC ACIDIC LAKES,

Oslo Univ. (Norway). Dept. of Biology.
For primary bibliographic entry see Field 5G.
W88-09889

ALTITUDINAL ZONATION IN A ROCKY MOUNTAIN STREAM,

Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
J. V. Ward.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 74, No. 2, p 133-199, August 1986. 27 fig, 9 tab, 94 ref, 2 append.

Descriptors: *Altitude, *Alpine regions, *Streams, *Limnology, *Aquatic plants, *Macroinvertebrates, *Aquatic habitats, Biomass, Species composition, Zooplankton, Temperature effects, Rocky Mountains, Algae, Physicochemical properties, Tundra.

Gradients of physicochemistry, aquatic vegetation, and macroinvertebrates were investigated along the longitudinal profile of a pristine stream from alpine tundra to plains. Rhithron characteristics were maintained over nearly the entire stream course, with an abrupt transition to potamon thermal conditions in lower reaches. Aquatic angiosperms, absent from mountain sites, were abundant in the plains stream. Epilithon biomass exhibited a bimodal pattern with maxima in the headwaters (bryophytes) and plains (chlorophytes). Abundant species of epilithic algae were either euryzonal, or restricted to upper or lower sites. Total zoobenthos density and biomass exhibited three-fold and six-fold increases, respectively, from tundra to plains. The downstream increase in species diversity exhibited a sigmoid pattern. Zoobenthic species distributions are categorized into four major altitudinal patterns. A faunal discontinuity between the lower foothills and plains corresponds to the transition from rhithron to potamon conditions. Temperature, food, aquatic plants, and possibly biotic interactions appear important in structuring faunal patterns. (Author's abstract)
W88-09890

PHYTOPLANKTON COMPOSITION AND DYNAMICS IN THE RIVER MEUSE (BELGIUM),

Facultes Universitaires Notre-Dame de la Paix, Namur (Belgium).Dept. of Biology.
J. P. Descy.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 78, No. 2, p 225-245, September 1987. 8 fig, 2 tab, 39 ref.

Descriptors: *Eutrophication, *Meuse River, *Water pollutiobn effects, *Population dynamics, *Phytoplankton, *Species composition, Hydrology, Aquatic plants, Aquatic habitats, Diatoms, Algae, Comparison studies, Belgium, Biomass, Limnology, Hydrological properties, Nutrient enrichment, Temperature effects, Flow rates, Seasonal variation, Light penetration, Europe, Rivers.

During 1983 and 1984, the phytoplankton of the river Meuse (Belgium) was observed in a reach between km 480 and km 500. The phytoplankton is dominated by diatom and green algae (respectively 62% and 26% of the 237 recorded taxa). The number of true planktonic forms is small: most of the suspended algae are tychoplanktonic. However, the true plankters largely dominate in density and biomass. The maximal cell density was 39,000 cells/ml and was recorded during a very low period. The maximal biomass was about 120 mg/cu m chlorophyll a. The seasonal successions seem to be contolled by flow rate, temperature and available light: a typical alternance of diatoms (spring, autumn) and green algae (summer) occured. The similarity with other data from the river Meuse and from other large European rivers is discussed. As a consequence of growing nutrient enrichment, these systems show a recent increase of cell densities of eutrophic taxa and plankton biomass, which are contolled mostly by physical parameters. (Author's abstract)
W88-09891

PHYTOPLANKTON STUDIES IN THE SZIGETKOZ SECTION OF THE DANUBE DURING 1981-1982,

Magyar Tudomanyos Akademia, Budapest. Station for Danube Research.
K. T. Kiss.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 78, No. 2, p 247-273, September 1987. 5 fig, 3 tab, 36 ref.

Descriptors: *Algae, *Diatoms, *Danube River, *Phytoplankton, *Limnology, Species composition, Biomass, Seasonal variation, Aquatic plants, Aquatic habitats, Eutrophication, Szigetkoz, Trophic level, Rivers, Hydrology, Hungary.

In the Szigetkoz area of Hungary, the Danube, its side channels and odd branches form a uniform water system. The changes of phytoplankton in the arms of the Danube were studied under various hydrological situations and 200 algal taxa were identified, a high proportion of which being sporadic only. During the vegetation period diatoms dominated, particularly the species of Thalassiosiraceae. The predominance of species of Cryptomonas, Chroomonas, Synura as well as some species belonging to the order Chlorococcales was also observed. As discharge of the Danube decreases phytoplankton increases. Water blooms also occurred frequently. In such periods, the actual trophicity of the Danube and its channel system was eutrophic, eupolytrophic. The rate of discharge of the Danube and the relative flow

velocities in the main channel and the side channel system of it also play an important role in phytoplankton similarity relationships. The section of the Danube in the region of Kis Alfold, and the Szigetkoz and Csallokoz side channels within that section, are basically involved in the natural self-purification and biogenic oxygen production processes of the Danube. (Author's abstract)
W88-09892

ALGAE IN GROUND WATERS BELOW THE ACTIVE STREAM OF A RIVER (BASIN OF THE MORAVA RIVER, CZECHOSLOVAKIA),
Ceskoslovenska Akademie Ved, Trebon. Dept. of Hydrobotany.
A. Poulickova.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 78, No. 1, p 65-88, May 1987. 9 fig, 2 tab, 40 ref.

Descriptors: *Morava River, *Groundwater, *Cyanophyta, *Species composition, *Limnology, *Seasonal variation, Population dynamics, Spatial distribution, Survival, Algae, Plankton, Czechoslovakia.

In a 4-yr. period (1981-1985) 49 samples were taken and more than 200 specimens of ground waters below the active stream of the Morava River were processed from 3 localities: the Truovicky brook at Belkovice, the Morava River at Chomoutov, the Morava-MILO in Olomouc (North Moravia, Czechoslovakia). In the aphotic environment of the shallow ground phototrophic organisms survived for a relatively long time in a viable state; in some cases they even reproduced. They must thus be included in evaluation of biological condition in those habitats. The quantitative occurrence of blue-green algae and algae both in surface water and in shallow horizons of the ground is subject to seasonal changes. At the horizon 15 cm below the bottom a slight shift compared with the situation on the surface can be observed. At deeper horizons seasonal variations are inconspicuous and numbers of algae at a very low level. It is probable that the colonization exhibited diurnal changes from the quantitative viewpoint, but this finding still needs to be documented. The number of algae decreased in the downward direction. The species composition of the phytocenose of the ground waters of the riverside is very varied, with common benthic as well as plankton species occurring there. They are mostly diatoms, the other groups of algae being represented less. From among green coccal algae the most widely represented is the genu Scenedesmus. (Alexander-PTT)
W88-09894

BIOMASS, STAND AREA, PRIMARY PRODUCTION CHARACTERISTICS AND OXYGEN REGIME OF THE CERATOPHYLLUM DEMERSUM L. POPULATION IN LAKE VECHTEN, THE NETHERLANDS,
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
E. P. H. Best, and J. H. A. Dassen.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 76, No. 4, p 347-367, November 1987. 5 fig, 5 tab, 36 ref.

Descriptors: *Lake Vechten, *Aquatic plants, *Limnology, *Macrophytes, *Primary productivity, Biomass, Isotope studies, Standing crop, Dissolved oxygen, Cycling nutrients, Organic carbon, Aquatic habitats, Species composition, Population dynamics, Seasonal variation, Limiting nutrients, Chlorophyll a, Lakes, Netherlands.

In 1973 three depth classes of the littoral macrophyte Ceratophyllum demersum L., rooting at depths of 1,2 and 3 m, were discernible in Lake Vechten in terms of growth characteristics. The 3 m depth class started to disappear in 1979 enabling the 2 m depth class to occupy new areas. The area colonized by the C. demersum L. population decreased in 1980, and the seasonal net production rate decreased. The molar ratio gross O2 production:C fixed varied with season. The respiration of the community ranged from 37 to 89% of gross production. The carbon fixation rates were highest in the upper 0.40 m of the vegetation. The carbon fixation of the community occurred largely by the macrophyte. A considerable part of the fixed radioactivity (2.1 to 39.3%, largely sugar) leaked out of the macrophyte upon shaking. Periphyton contributed 0.1 to 5.0% to the community fixation and excretion ranged from 0.3 to 21.9% of the 14C fixed in the incubation vessel. The ratio chlorophyll a:b decreased from the macrophyte apex downwards from 4.1 to 2.6. The conservative carbon budget, made for the 2 m depth class in 1978, indicated an annual gross production rate of 297.81 g C/sq m/y, of which the following losses occurred: 4.79 g C as maintenance and 43.43 g C as growth respiration, 18.66 g C as excretion, 121.70 g C as leakage. Detritus formation amounted to 98.90 g C/sq m/y. The oxygen exchange of the C. demersum community over 24 hours, as measured in enclosures, ranged from 0.93 to -2.66 g O2/sq m/d. The oxygen production was higher in the morning than in the afternoon, while its consumption occurred mainly in the first half of the night in spring and early summer and in the second half of the night in autumn, largely in the water column, but also at the bottom. (Author's abstract)
W88-09895

ZOOPLANKTON ABUNDANCE AND SPECIES COMPOSITION IN LAGUNA LA ORSINERA, A VENEZUELAN FLOODPLAIN LAKE,
Rhode Island Univ., Kingston. Dept. of Zoology.
S. Twombly, and W. M. Lewis.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 79, No. 1, p 87-107, December 1987. 9 fig, 1 tab, 38 ref. NSF Grants DEB 8116725, BSR 8315410, and BSR 8604655.

Descriptors: *Laguna la Orsinera, *Floodplain lakes, *Limnology, *Species composition, *Zooplankton, Seasonal variation, Biomass, Phytoplankton, Food chains, Food habits, Ecological effects, Lakes, Venezuela, Temperature effects, Light quality, Dissolved oxygen, Population dynamics.

Laguna la Orsinera, a lake lying in the floodplain of the lower Orinoco River, was sampled four days per week between late June and late December of 1984. Over the same interval, measurements were made of temperature, oxygen, transparency, and lake volume. During June, while the lake was shallow, turbid, and still isolated from the Orinoco River, the densities of all zooplankton species were extremely low. Increases in the abundance of selected populations, probably involving resting stages, began three weeks prior to inundation of the lake by the Orinoco River in late July. An extended sequence of species replacements extended through December, six weeks after the drainage of the lake into the river. Cladocerans, which reached substantial densities (mean, 45/liter), were almost entirely restricted to the first two months of this sequence. Declines in populations of cladocerans coincided with high densities of Chaoborus, a zooplankton predator. Populations of three copepod species (two diatomids, one cyclopoid) expanded just after inundation of the lake, but reached their peak abundances more slowly, and persisted in abundance until December. Rotifers were also abundant; the peaks in abundance of rotifer species were spread from early July to December, and suggest differential responses to changing abundance and composition of phytoplankton foods. Comparisons with two tropical lakes not occupying floodplains indicate that, on an annual basis, Laguna la Orsinera has a higher species diversity and a greater degree of equitability among species than would be expected for non-floodplain lakes. This is consistent with the hypothesis that externally-driven physical and chemical changes in the lake induce a greater range of environmental conditions in floodplain lakes. The greater range of conditions leads to a more extensive sequence of species replacements and allows a greater number of species to reach significant abundance. (Author's abstract)
W88-09896

NITROGEN BUDGET OF AN OLIGOTROPHIC COLD WATER POND,
Oregon Univ., Eugene. Dept. of Biology.
W. K. Dodds, and R. W. Castenholz.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 79, No 4, p 343-362, April 1988. 2 fig, 7 tab, 68 ref. National Institutes of Health BSRG Grant S07 RR 07080.

Descriptors: *Mare's Egg Spring, *Nitrogen budget, *Oligotrophic lakes, *Limnology, Limiting nutrients, Cycling nutrients, Nitrates, Phosphates, Light quality, Temperature effects, Ponds, Lakes, Oregon.

Inflows and outflows of nitrogen were quantified for Mare's Egg Spring, a 50 m wide, oligotrophic, spring-fed pond in Oregon. The nitrogen fixing cyanobacterium Nostoc pruniforme was extremely abundant. The pond was a constant 4.6 C, always low in total combined nitrogen, and high in soluble reactive phosphate. Light was the only apparent variable environmental parameter. Major nitrogen influxes were: solutes in inflowing water (48%), tree bole infall (27%), beaver excretion (15%), dry atmospheric deposition (3.8%), and in situ nitrogen fixation (3.8%), with other combined N inputs < 3%. Nitrogen effluxes were: solutes in outflowing water (42%), burial (41%), and particulate outflow (16%), with all other outputs < 1%. Calculations of output and input of nitrogen agreed within 10%. The concentration of dissolved combined nitrogen in the pond was controlled by the nitrogen content of the incoming water since all organismically mediated fluxes in the pond < 10% of the total incoming nitrogen flux and relative amounts of dissolved organic N and NO3(-) did not change upon passage through the pool. Comparisons with other nitrogen budgets show that this pond is like a stream with respect to factors influenced by water replacement nutrient spiraling, and relative importance of nitrogen fixation as compared to external loading and like a lake with respect to storage of litter infall (sedimentary burial). (Author's abstract)
W88-09897

COMMON LOON REPRODUCTION AND CHICK FEEDING ON ACIDIFIED LAKES IN THE ADIRONDACK PARK, NEW YORK,
State Univ. of New York, Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 5C.
W88-09908

BREEDING BIOLOGY OF TREE SWALLOWS IN RELATION TO WETLAND ACIDITY,
Canadian Wildlife Service, Ottawa (Ontario).
For primary bibliographic entry see Field 5C.
W88-09909

LEAF DECOMPOSITION IN AN OZARK CAVE AND SPRING,
Arkansas Univ., Fayetteville. Dept. of Zoology.
P. P. Brussock, L. D. Willis, and A. V. Brown.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 263-269, June 1988. 3 fig, 1 tab, 21 ref.

Descriptors: *Leaves, *Decomposing organic matter, *Biodegradation, *Caves, *Macroinvertebrates, *Limnology, Light quality, Liminting nutrients, Temperature effects, Streams, Detritus, Oak trees, Flow rates, Springs, Karst.

Decomposition of leaves was compared among sites in a stream that originates deep in a cave and then emerges as a spring brook. White oak (Quercus alba) leaf packs and plastic controls were placed in four similar riffle areas: (1) in the cave above a sink hole; (2) in the cave below a sink hole; (3) in the spring under an overhang; and (4) in the spring exposed to direct sunlight (through a forest canopy). Flow, temperature, and other aspects of physical-chemical water quality were constant among sites while availability of natural leaf liter, food abundance and variety, light, and the number and types of invertebrates varied. Processing rates (-k) at the cave sites (1 = 0.0075, 2 = 0.0085) were faster than rates for white oak reported for surface streams, despite a paucity of invertebrates in the cave and similar temperatures. Leaf packs which received sunlight had ten times more invertebrates associated with them than those under the over-

hang, but similar processing rates (0.019 and 0.024 respectively). Because of these results, we suspect that the decomposition rates outside the cave were faster due to factors other than the macroinvertebrates. (Author's abstract)
W88-09924

SESTON AND DISSOLVED ORGANIC CARBON TRANSPORT DURING STORM FLOWS IN A NATURAL AND A DISTURBED COASTAL PLAIN STREAM,
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 5B.
W88-09925

EFFECTS OF FRESHWATER MACROPHYTES ON SEDIMENT CHEMISTRY,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
R. L. Chen, and J. W. Barko.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 279-289, June 1988. 5 fig, 1 tab, 25 ref.

Descriptors: *Aquatic plants, *Sediments, *Macrophytes, *Water chemistry, *Cycling nutrients, *Limnology, Chemical properties, Spatial distribution, Limiting nutrients, Bioaccumulation, Nutrients, Nitrogen, Phosphorus, Nutrients.

Changes in the vertical distribution of sediment redox potential and nutrient availability were examined during the growth of freshwater macrophytes in a greenhouse facility. Sagittaria latifolia, an emergent macrophyte species with an extensive root system, markedly affected sediment redox, resulting in a change from reduced to excised conditions within six weeks. In contrast, Hydrilla verticillata, a submersed macrophyte species with a relatively minor root system, did not appreciably alter sediment redox. Nutrient uptake by both species substantially reduced concentrations of nitrogen and phosphorus in sediments. Decreased concentrations of sediment nutrients appear to have resulted primarily from nutrient uptake by macrophytes rather than from change in sediment redox potential. (Author's abstract)
W88-09926

VARIABILITY IN BENTHIC INVERTEBRATE DENSITY ESTIMATES FROM STREAM SAMPLES,
Chadwick and Associates, Littleton, CO.
S. P. Canton, and J. W. Chadwick.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 291-297, June 1988. 1 fig, 2 tab, 22 ref.

Descriptors: *Benthos, *Macroinvertebrates, *Population density, *Limnology, *Statistical methods, Data interpretation, Mathematical studies, Species composition, Streams biota.

The problem of variability in benthic density estimates from stream sampling was reassessed using data from a number of stream studies. When data were analyzed assuming a negative binomial distribution and a tolerated precision of 40% of the mean, it was apparent that earlier estimates of hundreds of samples required to estimate density were inaccurate. Based on total numbers of organisms, in most cases, six samples were sufficient for a precision of 40%. From three samples on, variability (as measured by the coefficient of variation) actually increased with increased number of samples. Examination of two long-term studies revealed that taking three samples yielded reliable estimates of benthic density with reasonable coefficients of variation. However, such sampling schemes yielded significantly lower numbers of species than when six or 12 samples were taken. It is suggested that six replicates, each a composite of two samples, would be sufficient for stream studies, by providing a reliable estimate of total density and a fairly complete species list. (Author's abstract)
W88-09927

MUSSEL FAUNA ASSOCIATED WITH WING DAMS IN POOL 7 OF THE MISSISSIPPI RIVER,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
A. C. Miller.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 299-302, June 1988. 1 tab, 11 ref.

Descriptors: *Mussels, *Mississippi River, *Species composition, Population dynamics, Limnology, Dams, Rivers, Sampling, Molluska.

Twenty-three species of freshwater mussels (Mollusca: Unionidae) were collected by divers in May, 1987, at 32 sites on and between wing dams in Pool 7 of the upper Mississippi River. Five species (Amblema plicata, Obliquaria reflexa, Obovaria olivaria, Lampsilis ventricosa and Quadrula pustulosa) comprised 90% of the fauna and were found at 88-100% of the sites. Specimens of Actinonaias ligamentina, Plethobasus cyphyus, and Strophitus undulatus, last reported in 1966, were collected alive. (Author's abstract)
W88-09928

SPATIAL PARTITIONING OF MICROHABITATS IN LITTORAL CLADOCERAN COMMUNITIES,
Mercyhurst Coll., Erie, PA. Dept. of Biology.
C. D. DiFonzo, and J. M. Campbell.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 303-313, June 1988. 6 tab, 26 ref.

Descriptors: *Littoral environment, *Cladocera, *Lake erie, *Limnology, *Aquatic habitats, Species composition, Population dynamics, Statistical analysis, Lakes, Pennsylvania, Spatial distribution.

Sampling of littoral cladoceran populations was conducted in the Fall of 1986 at four sites in Pennsylvania: a small man-made pond, a swamp, a natural glacial lake (Lake Lacawac), and an embayment of Lake Erie. Microhabitats sampled included various plant species, rocks, and the water column. Densities and percentages of individual species in the microhabitats were used to calculate community coefficients of similarity among and within microhabitats, and to perform ANOVA and SNK tests. Cladoceran communities were more similar within than between microhabitats, indicating there is significant variation in community structure among littoral microhabitats. Densities of some cladoceran species varied significantly among microhabitats. Acroperus harpae, Camptocercus rectirostris, and Pleuroxus procurvus were more abundant on plants than on rocks in the embayment. Chydorus brevilabris and Alona guttat were more abundant on Myriophyllum than Ulothrix in the pond. In Lake Lacawac, A. harpae was more abundant on plants than rocks, while Alona rustica and C. brevilabris preferred rocks. Bosmina sp. showed significant diel density variation in Lake Lacawac. Coexisting species of Alona and Chydorus in the littoral zone showed evidence of density variation among microhabitats. Some species of cladocerans seem to be specialized for certain microhabitats, and these specializations may be the basis for spatial partitioning of resources in multispecific communities of these animals. (Author's abstract)
W88-09929

ROLE AND INTERACTIONS OF SUBMERSED MACROPHYTES IN A SHALLOW WISCONSIN LAKE,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Research.
S. Engel.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 329-341, June 1988. 4 fig, 6 tab, 20 ref.

Descriptors: *Macrophytes, *Limnology, *Aquatic plants, *Seasonal variation, Species composition, Population dynamics, Aquatic animals, Aquatic habitats, Food chains, Food habits, Eutrophication, Lakes, Wisconsin, Phytoplankton, Biomass, Fish food, Detritus.

Growth and community organization of submersed macrophytes were studied in a southern Wisconsin impoundment in relation to macroinvertebrates, fishes, and phytoplankton. Macrophytes covered 50 to 70% of the lake bed in summer, growing to a water depth of 3.5 m. Total biomass peaked in late July at 130 to 200 gm dry wt/sq m. Undisturbed macrophyte beds were stratified into canopy, midwater, and basal layers. Narrow-leaved pondweeds dominated among 13 vascular plant species. But mechanical harvesting, in the fourth and fifth years of the study, disrupted vertical stratification and exposed the lake bed to monotypic growths of water stargrass. Three-fourths of macroinvertebrate species were found on or beneath macrophytes during summer. Few species comprised > 5% of individuals in plant or bottom samples. Most macroinvertebrates consumed algae and detritus derived from macrophyte decay. Fishes under 120 mm total length were sheltered by plant beds denser than 200 gm dry wt/sq m. Larger bluegills (Lepomis macrochirus Raf.) and largemouth bass penetrated looser foliage or remained offshore. Macrophyte decay and plant harvesting created channels used by bass as cruising lanes. Plant-dwelling fishes grazed mainly aquatic insect larvae or microcrustaceans. Bass shifted to fry, while bluegills turned to macrophyte tissue, as summer progressed. Blue-green algal blooms developed in July when curly-leaf pondweed decayed or other plants were > 3.5 to 0.6 m. (Author's abstract)
W88-09931

ORGANIC MATTER CONTENT IN SEDIMENTS OF THREE NAVIGATION POOLS ALONG THE UPPER MISSISSIPPI RIVER,
J. C. Ritchie.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 343-349, June 1988. 4 tab, 18 ref.

Descriptors: *Environmental effects, *Mississippi River, *Sediments, *Organic carbon, *Sedimentation rate, Decomposing organic matter, Chemical analysis, Limnology, Rivers.

Organic matter content was measured in 84 sediment profiles collected in navigation Pools 7, 8, and 9 along the upper Mississippi River. Organic matter content ranged from 0.25 to 22.80% with a mean content of 3.53 + or - 2.06% but did not vary significantly with depth. Organic matter content in Pool 7 was significantly higher than that measured in Pool 8 or Pool 9. Organic matter content of sediment deposited between 1964-1977 was generally less than that in sediments deposited between 1954-1964 which was usually less than that in sediments deposited prior to 1954. Based on measured sediment accumulation rates in Pools 7, 8, and 9, the average influxes of organic matter for the period between 1954 and 1977 were 421, 265, and 328 g/sq m/yr, respectively. (Author's abstract)
W88-09932

MORPHOLOGY AND ECOLOGY OF URNATELLA GRACILLS LEIDY, (ENTOPROCTA), A FRESHWATER MACROINVERTEBRATE FROM ARTIFICIAL RIFFLES OF THE TOMBIGBEE RIVER, MISSISSIPPI,
Central Michigan Univ., Mount Pleasant. Dept. of Biology.
D. K. King, R. H. King, and A. C. Miller.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 351-360, June 1988. 1 fig, 4 tab, 20 ref.

Descriptors: *Tombigbee River, *Aquatic habitats, *Macroinvertebrates, *Limnology, Species composition, Population dynamics, Biomass, Aquatic animals, Rivers.

Estimates of density and biomass of Urnatella gracilis Leidy, a freshwater filter-feeding entoproct, were made from samples obtained with a Petite Ponar grab sampler from a newly constructed riffle habitat in an abandoned channel of the Tombigbee River, near Columbus, Mississippi. Colonies of one, two, three and occasionally four stalks (individuals) were observed on gravel substrata. An average of 144,614 stalks/sq m were found. Ash-free dry weight biomass averaged 876.7 mg/sq m. This organism was dominant in terms of both density and biomass. Urnatella gracilis was found to be a significant early colonizer of new substrata and an important member of the macroinvertebrate community. (Author's abstract)

W88-09933

ASPECTS OF BIOCHEMICAL SULPHUR CONVERSIONS IN SEDIMENTS OF A SHALLOW SOFT WATER LAKE,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 5B.
W88-09934

DISTRIBUTION AND ECOLOGY OF WATER HORSETAIL (EQUISETUM FLUVIATILE) IN NORTHERN WETLANDS,
University of Western Ontario, London. Dept. of Geography.
C. M. Pearce, and L. D. Cordes.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 383-394, June 1988. 1 fig, 3 tab, 35 ref.

Descriptors: *Mackenzie Delta, *Wetlands, *Limnology, *Aquatic plants, Population dynamics, Seasonal variation, Spatial distribution, Reproduction, Aquatic habitats, Growth, Tundra, Canada, Grazing, Flooding, Ice breakup.

The distribution of Equisetum fluviatile on the Mackenzie Delta, N.W.T., Canada was examined between 1981 and 1987. E. fluviatile occupied mineral and organic substrates on the lower shorelines of stable channels and lakes that were flooded for 1 to 3 months during the growing season, and received 1 to 15 cm annual deposits of silty alluvium. The distribution of E. fluviatile in the tundra of the outer delta (north of 69 degrees latitude) was patchy and restricted to infilling inter-levee basins. Sexual reproduction was not observed during the study; E. fluviatile propagated and colonized new sites by the production of annual stems from underground rhizomes and dispersal of plant fragments during ice breakup flooding and muskrat grazing. Natural proliferation of stem fragments was observed, but the propagules did not survive. (Author's abstract)
W88-09935

NOTE ON THE OCCURRENCE OF UNUSUAL PATCHES OF SENESCENT PERIPHYTON IN AN OKLAHOMA STREAM,
Oak Ridge National Lab., TN. Environmental Sciences Div.
A. J. Stewart.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 395-399, June 1988. 3 tab, 17 ref. NSF BSR-8307014 and DOE Contract No. DE-AC05-84OR21400.

Descriptors: *Diatoms, *Periphyton, *Plant disease, *Aquatic plants, Brier Creek, Oklahoma, Streams.

In April, 1985, many visually distinct circular patches developed on periphyton-covered substrates in all pools and in many riffles over a 1 + km reach of Brier Creek in southcentral Oklahoma. Periphyton within these patches was grey and senescent, whereas periphyton immediately outside of the patches appeared normal. The patches ranged from 7 to 46 cm in diameter and occurred in water depths ranging from 3 to 55 cm; some pools contained more than a hundred such patches. Diatoms predominated in the periphyton when the patches were evident, and empty frustules of the diatom Synedra ulan occurred with a slightly greater frequency within the patches than they did just outside of the senescent areas. The circular shape of the patches suggested a pathogen that spread from cell to cell entirely within the benthic boundary layer. However, microscopic examination did not reveal the presence of common parasitic fungi, and attempts to propagate the pattern by transferring periphyton from within senescent patches to adjacent areas where periphyton appeared healthy were unsuccessful. (Author's abstract)
W88-09936

TEMPORAL AND SPATIAL VARIABILITY OF THE EULITTORAL EPILITHIC PERIPHYTON, LAKE TAHOE, CALIFORNIA-NEVADA,
California Univ., Davis. Div. of Environmental Studies.
J. E. Aloi, S. L. Loeb, and C. R. Goldman.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 401-410, June 1988. 4 fig, 26 ref. University California-Davis NSF-BSR No. 84-09448.

Descriptors: *Land development, *Diatoms, *Lake Tahoe, *Oligotrophic lakes, *Limnology, Biomass, Seasonal variation, Organic carbon, Population dynamics, Ecological effects, Algae, Littoral zone, Temporal distribution, Spatial distribution.

The temporal and spatial variability of an epilithic diatom community in the eulittoral zone of Lake Tahoe was monitored for three years. Lake Tahoe is a deep, subalpine lake in the Sierra Nevada Mountains of California and Nevada. Although the lake is considered to be oligotrophic, the productivity of the eulittoral (0-2 m) epilithic periphyton is very high, reaching a peak biomass at one site of 58 g C/sq m in spring of 1985. More typical annual maxima were in the range of 15-25 g C/sq m at more productive sites. The epilithon shows great temporal and spatial variation in biomass. To quantify this variability, total particulate carbon was measured monthly or biweekly at 8 sites between 1983 and 1985. Annual regrowth of the eulittoral epilithon began during late winter, and reached maximal biomass during the spring and early summer months. Following this peak, most of the algal mat sloughed, leaving only a small understory. In addition, significant and consistent differences in epilithon biomass were found between sites adjacent to land-based development and disturbance, and sites far from disturbance. Several sites adjacent to disturbed areas had up to 20 times greater biomass than sites far removed from disturbance. (Author's abstract)
W88-09937

VEGETATION AND ECOLOGY OF MESOTROPHIC AND EUTROPHIC FENS IN WESTERN FINLAND,
Helsinki Univ. (Finland). Dept. of Botany.
H. Heikkila.
Annales Botanici Fennici ABOFAQ, Vol. 24, No. 2, p 155-175, 1987. 9 fig, 11 tab, 65 ref.

Descriptors: *Mires, *Fens, *Wetlands, *Finland, *Trophic level, Statistical analysis, Mathematical studies, Species composition, Population dynamics, Cycling nutrients, Limiting nutrients, Vegetation, Mosses, Ordination, Classification, Peat bogs, Phosphorus, Potassium, Calcium, Magnesium, Iron, Hydrogen ion concentration, TWINSPAN.

Sixty-five sample plots were studied in 38 mires in western Finland. In each sample plot five quadrats were marked out, the pH of the mire water was measured and two surface peat samples were taken. The peat samples were analyzed for P, K, Ca, Mg and Fe. The vegetation was grouped with detrended correspondence analysis (DCA) ordination analysis and TWINSPAN classification analysis. The relations of the vegetation and environmental factors were studied with Spearman's rank correlation and hybrid ordination. The current Finnish mire site type classification was carried out in further detail. Mesotrophic mud-bottom flark fens were divided into mesotrophic and meso-eutrophic groups. Eutrophic pine swamps with Sphagnum fuscum were divided into two groups according to the trophic status and the mire margin effect. Mesotrophic Calliergon stramineum flark fen was separated from Drepanocladus flark fens. A new group is Sphagnum obtusum rich fens. According to Spearman's rank correlations, the ranking of the samples by TWINSPAN and the first two axes of DCA is very strongly correlated with several environmental factors. The sample ranking does not follow any single factor, but all the nutrients and the water surface percentage are strongly correlated. The factors best explaining the sample ranking were pH and K. In hybrid ordination the factor best explaining the ordination of DCA was the water surface percentage. (Author's abstract)
W88-09941

NICHE CONGRUENCY OF FRESHWATER GASTROPODS IN CENTRAL NORTH AMERICA WITH RESPECT TO SIX WATER CHEMISTRY PARAMETERS,
Winnipeg Univ. (Manitoba). Dept. of Biology.
E. Pip.
The Nautilus NUTLAS, Vol. 102, No. 2, p 65-72, April 1988. 3 fig, 2 tab, 28 ref.

Descriptors: *Statistical analysis, *Gastropods, *Niches, *Aquatic animals, *Aquatic habitats, *Water chemistry, *Limnology, *Cluster analysis, Dissolved organic matter, Population dynamics, Species composition, Mathematical studies, Ecological effects, Spatial distribution, Streams, Lakes, Alkalinity, Phosphorus, Sulfates, Chloride, North America, Principal component analysis.

Occurrences of freshwater gastropods were studied at 430 sites in central North America (47-54 deg N and 94-106W) with respect to total alkalinity, total dissolved solids, chloride, sulfate, phosphorus, and dissolved organic matter. Mean niche positions for the gastropods were calculated for the six combined water chemistry parameters by comparing mean values for each species using agglomerative hierarchical cluster analysis. Total niche relations were examined by calculating and summing the amount of overlap in the observed ecological tolerance ranges for the six parameters for each species pair, and applying cluster and principal component analyses. The results showed that the species occupied a broad spectrum of niches, with progressively increasing ecological range. Gastropods with low mean inorganic values and narrow niche widths were interpreted as specialists for waters with low concentrations of dissolved inorganic materials. Species which clustered together in terms of central tendencies of occurrence often differed from each other in terms of overall niche similarity, and vice versa. Competition may have been more important in waters with low inorganic concentrations. (Author's abstract)
W88-09943

FACTORS AFFECTING THE DISTRIBUTION OF SPHAERIID BIVALVES IN BRITANNIA BAY OF THE OTTAWA RIVER,
Guelph Univ. (Ontario). Dept. of Zoology.
B. W. Kilgour, and G. L. Mackie.
The Nautilus NUTLAS, Vol. 102, No. 2, p 73-77, April 1988. 7 fig, 3 tab, 20 ref. NERC Grant A-9882.

Descriptors: *Mollusks, *Sediments, *Ottawa River, *Coastal waters, *Spatial distribution, Aquatic habitats, Organic carbon, Particulate matter, Britannia Bay, Water depth, Ontario, Sampling.

Distribution of Sphaeriidae in Britannia Bay of the Ottawa River was not homogeneous and was primarily affected by sediment particle size and depth. Total sphaeriid diversity is maximal at particle sizes near 0.18 mm. Total sphaeriid density and abundance of the genus Pisidium increase with decreasing water depth. Distribution of species within the general Pisidium and Musculium is variable. These data indicate that comparisons of pisidiid distribution should consider at least depth, and particle size in the sampling design. (Author's abstract)
W88-09944

SUPPRESSION OF WATER HYACINTH BY THE EXOTIC INSECT NEOCHETINA EICHHORNIAE IN BANGALORE, INDIA,
Indian Inst. of Horticultural Research, Bangalore.
For primary bibliographic entry see Field 4A.
W88-09945

TOXICITY OF INDUSTRIAL EFFLUENTS TO THE FRESHWATER CAT FISH MYSTUS KELETIUS,
Saint Xavier's Coll., Palyamkottai (India). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W88-09946

MERCURY IN FISH AND INVERTEBRATES IN LAKE MJOSA (KVIKKSOLV I FISK OG EVERTEBRATER I MJOSA),
Kongelige Selskap for Norges Vel, Skjeten.
For primary bibliographic entry see Field 5B.
W88-09947

ENVIRONMENT ORIENTED MANAGEMENT SYSTEM OF RIVER BASIN: CASE STUDY IN YAHAGI RIVER BASIN, CENTRAL JAPAN,
Nagoya Univ. (Japan). Dept. of Earth Sciences.
For primary bibliographic entry see Field 6A.
W88-09949

TRANSFER AND OCCURRENCE OF LARGE MERCURY RESISTANCE PLASMIDS IN RIVER EPILITHON,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
M. J. Bale, J. C. Fry, and M. J. Day.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 4, p 972-978, April 1988. 4 fig, 3 tab, 39 ref.

Descriptors: *Pseudomonas, *Bacteria, *Genetics, *Mercury, *Heavy metals, Plasmids, Mercury Resistance, Ultraviolet radiation resistance, *River Taff, Wales, Temperature effects.

In situ mating experiments were done in the River Taff, South Wales, U.K., by using a natural mercury resistance plasmid (pQM1) isolated from a mixture of epithilic bacteria in vitro. The river temperature from March to November was found to influence transfer frequencies strongly (6.8 x 10 to the minus 9th power to 0.015 per recipient). A linear relationship existed between log transfer frequency and river temperature (6 to 21 degrees C.), a 2.6 degree change in temperature giving a 10-fold change in transfer frequency. In vitro experiments showed that pQM1 transferred most efficiently between fluorescent pseudomonads and that one epilithic isolate (Pseudomonas fluorescens) was an efficient donor in situ. Experiments with a P. putida recipient showed that intact epilithic bacterial communities could transfer mercury resistance plasmids in situ at frequencies of up to 0.00000375 per recipient. Nineteen of the large (>250 kilobase) plasmids isolated by transfer into P. putida were studied in detail and grouped into seven types by restriction digests. Mercury resistance and UV resistance were found to be common linked phenotypes in 19 of the 23 plasmids tested. (Author's abstract)
W88-09965

PHENOTYPIC AND GENOTYPIC COMPARISON OF ESCHERICHIA COLI FROM PRISTINE TROPICAL WATERS,
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W88-09966

COMPARATIVE ANALYSIS OF THE CHEMICAL COMPOSITION OF MIXED AND PURE CULTURES OF GREEN ALGAE AND THEIR DECOMPOSED RESIDUES BY CARBON-13 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY,
Geological Survey, Reston, VA.
J. L. Zelibor, L. Romankiw, P. G. Hatcher, and R. R. Colwell.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 4, p 1051-1060, April 1988. 6 fig, 8 tab, 35 ref.

Descriptors: *Chlorophyta, *Cladophora, *Biomass, *Decomposing organic matter, *Algae, *Limnology, *Spectroscopy, *Biodegradation, *Chemical analysis, *Bacteria, *Microbial degradation, *Aquatic environments, *Sedimentation, Alghumin, Nuclear magnetic resonance spectroscopy, Carbon radioisotopes, Aerobic conditions, Anaerobic conditions, Wetlands, Lakes.

Humic substances are highly aliphatic. These aliphatic macromolecules, predominantly paraffinic in structure, are prevalent in marine and lacustrine sediments and are believed to originate from algae or bacteria. A comparative study of mixed and pure cultures of green algae and their decomposed residues was performed using solid-state C-13 nuclear magnetic resonance spectroscopy as the primary analytic method. Results obtained confirm the presence of components that are chemically refractory and that are defined as alghumin and hydrolyzed alghumin. These were detected in heterogeneous, homogeneous, and axenic biomasses composed of several genera of Chlorophyta. Although the chemical composition of algal biomass varied with culture conditions, the structure of the alghumin and hydrolyzed alghumin demonstrated by C-13 nuclear magnetic resonance spectroscopy appeared to be constant for the members of the Chlorophyta examined. The alghumin was dominated by carbohydrate-carbon, with minor amounts of amide or carboxyl carbon and paraffinic carbon, the latter surviving strong hydrolysis by 6 N HCL (hydrolyzed alghumin). Bacterial decomposition of heterogeneous algal biomass labeled with C-13 was conducted under both aerobic and anaerobic conditions to determine chemical structure and stability of the refractory material. The refractory fraction ranged from 33% in aerobic to 44% in anaerobic cultures. The refractory fraction recovered from either aerobic or anaerobic degradation comprised 40% alghumin, which represented an enrichment by 10% relative to the proportion of alghumin derived from whole cells of algae. The paraffinic component in the hydrolyzed alghumin of whole algal cells was found to be 1.8% and increased to 5.1 and 6.9% after aerobic and anaerobic bacterial degradation, respectively. Alga-derived macromolecular compounds deposited in aquatic environments (alghumin) probably contribute to sedimentary humic substances. (Author's abstract)
W88-09969

IMPACT OF UREA TOP DRESSING OF FOREST WATER CATCHMENT AREAS ON THE BIOLOGICAL SUFFICIENCY AND WATER QUALITY IN MOUNTAIN STREAMS: III. MACROZOOBENTHIC PRODUCTION,
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
For primary bibliographic entry see Field 5C.
W88-09971

EFFECTS OF PHOSPHORUS REMOVAL ON THE MAXIMAL ALGAL GROWTH IN BIOASSAY EXPERIMENTS WITH WATER FROM FOUR DUTCH LAKES,
Hoogheemraadschap van Rijnland, Leiden (Netherlands).
For primary bibliographic entry see Field 5G.
W88-09989

DISTRIBUTION OF MACROPHYTES IN RELATION TO ENVIRONMENTAL FACTORS IN THE TER RIVER, NORTHEAST SPAIN,
Barcelona Univ. (Spain). Dept. de Ecologia.
J. Penuelas, and F. Sabater.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 1, p 41-58, 1987. 8 fig, 3 tab, 23 ref. Comision Asesora de Investigacion Cientifica y Teenica (Spain) Grant 478/81.

Descriptors: *Lotic environment, *Ecological distribution, *Macrophytes, *Rivers, *Aquatic plants, *Aquatic populations, Bryophytes, Spatial distribution, Statistical analysis, Aquatic habitats, Oligotrophy, Eutrophication, Reservoirs, Spain.

Most factors measured in water quality studied increase downstream coinciding with changes in the aquatic vegetation, from typical species of fast-flowing oligotrophic waters to those of slower-flowing eutrophic waters. Several statistic analyses were carried out to relate physical and chemical parameters with plant distribution. Five vegetation types are found in a longitudinal distribution along the river system. They are dominated by bryophytes in the initial parts before the reservoirs and by higher plants in the final parts after the reservoirs. (Author's abstract)
W88-09990

SEASONALITY, POPULATION DYNAMICS, AND PRODUCTION OF DAPHNIA LONGISPINA IN THE SUBTROPICAL LAKE BHIMTAL (U.P.), INDIA,
Kumaun Univ., Naini Tal (India). Dept. of Zoology.
P. C. Sharma, and M. C. Pant.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 1, p 71-80, 1987. 8 fig, 1 tab, 20 ref.

Descriptors: *Daphnia, *Zooplankton, *Waterfleas, *Seasonal variation, *Population dynamics, Population density, Aquatic populations, Plankton, India, Productivity, Lakes, Subtropil zone, Baseline studies, Temperature effects.

Seasonal variation in population density, birth rate, mortality, and production of a daphnid was studied in a high altitude sub-tropical lake. A bimodal growth curve with maxima during summer and autumn was observed. A positive correlation was reported between fecundity and death rate, probably due to a difference in age specific death rate combined with a high relative frequency of juvenile in a growing population. The production of Daphnia longispina correlates better with temperature than with food. The P/B ratio was higher during summer and autumn months. (Author's abstract)
W88-09991

INTERACTION OF SELENATE AND SELENITE WITH SELECTED FRESHWATER SEDIMENTS,
Saskatchewan Univ., Saskatoon. Dept. of Soil Science.
N. G. Lipinski, P. M. Huang, U. T. Hammer, and W. K. Liaw.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 1, p 107-114, 1987. 4 fig, 3 tab, 18 ref. Natural Sciences and Engineering Research Council of Canada Strategic Grant G-1296.

Descriptors: *Path of pollutants, *Selenium, *Selenite, *Selenate, *Lakes, *Lake sediments, *Biodegradation, Sediments, Katepwa Lake, Buffalo Pound Lake, Canada, Oxidation, Chemical reactions, Reduction.

The transformation of selenium in natural systems is of interest because of its importance as an essential nutrient for animals and human beings as well as its reputation as a toxin similar in effect to arsenic. Selenite and selenate at submicrogram levels were added to suspension of two lake sediments (Buffalo Pound and Katepwa Lakes) from southeastern Saskatchewan, Canada. The sediment from Buffalo Pound Lake rapidly oxidized selenite in an Arrhenuis type reaction and followed first order kinetics. The sediment from Katepwa Lake oxidized selenite, but at a much slower rate. The oxidation of selenite is an abiotic process. The sediment from Katepwa Lake also reduced selenate, while Buffalo Pound Lake sediment did not. The reduction of selenate is likely mediated by biotic activity, associated biochemical processes, and/or organic matter. (Author's abstract)
W88-09992

LIMNOLOGICAL CHARACTERISTICS OF TWO EUTROPHIC AND FOUR MESOTROPHIC LAKES IN WEST-CENTRAL FLORIDA,
University of South Florida, Tampa. Dept. of Biology.
C. J. Dawes, B. C. Cowell, W. E. Gardiner, and S. M. Scheda.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 2, p 171-203, 1987. 9 fig, 11 tab, 66 ref.

Descriptors: *Eutrophication, *Phytoplankton, *Zooplankton, *Lakes, *Mesotrophic lakes, *Limnology, Mathematical Studies, Multivariate Analysis, Plankton, Chlorophyll, Eutrophic Lakes, Rotifers, Regression analysis, Florida.

Limnological characteristics of six subtropical lakes were monitored to determine the factors which regulate chlorophyll a concentrations and

phytoplankton standing crops. Most physical-chemical variables showed non-significant differences with depths but differences between lakes were often large. Phytoplankton blooms occurred throughout the year and there were marked differences between the hypereutrophic and mesotrophic lakes in chlorophyll a concentration, standing stocks, and dominant species. Densities of total zooplankton and rotifers in the hypereutrophic lakes were 3 to 6-fold greater than in the mesotrophic lakes. Regression models for chlorophyll a and total phytoplankton cell volumes were calculated for each lake and for all lakes combined, but R-squared values and numbers of shared variables tended to be low indicating the need for additional variables and more frequent sampling. (Author's abstract)
W88-09994

COMPARATIVE PRODUCTIVITY OF TWO PONDS IN THE VICINITY OF LAKE ST. JOHN, QUEBEC (PRODUCTIVITE COMPAREE DES DEUX ETANGS SITU A PROXIMITE DU LAC SAINT-JEAN, AU QUEBEC),
Quebec Univ., Chicoutimi. Dept. des Sciences Fondamentales.
L. M. Lalancette.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 2, p 205-223, 1987. 11 fig, 4 tab, 35 ref.

Descriptors: *Ponds, *Ecosystems, *Eutrophication, *Limnology, *Productivity, *Zooplankton, Reservoirs, Benthic fauna, Sediments, Lakes, Lake St. John, Quebec, Canada.

In 1980 and 1981, the productivity of two ponds near Lake St. John were evaluated. One, the pond of Desbiens, did not communicate with Lake St. John and the other, the pond of St. Gedeon, was connected to the lake. The aim of this study was to evaluate the contribution that a pond could make to the increase in productivity of Lake St. John, which is a reservoir. The pond of Desbiens is more productive than Lake St. John but 2-3 times less productive than the pond of St. Gedeon. The pond of Desbiens shows an advanced degree of eutrophication whereas the pond of St. Gedeon is similar to northern lakes in its physico-chemistry, zooplankton, sediments, and benthic fauna. (Author's abstract)
W88-09995

GERMINATION AND GROWTH OF POTAMOGETON PECTINATUS (L.) AT DIFFERENT WATER DEPTHS IN LAKE NAINITAL, UTTAR PRADESH, INDIA,
Kumaun Univ., Naini Tal (India). Dept. of Botany.
R. Purohit, and S. P. Singh.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 2, p 251-256, 1987. 3 fig, 1 tab, 10 ref.

Descriptors: *Germination, *Plant growth, *Tubers, *Aquatic plants, *Sago pondweed, Water depth, Plants, India, Lakes, Macrophytes.

Data on germination of tubers and subsequent growth of young plants of Potamogeton pectinatus were recorded at different depths of the water column in Lake Nainital. The depth of the euphotic zone is about 5 m. Tubers were placed at 1, 2.5, 5.0, 7.5, and 10 m water depth in brass net bags. A highly significant negative correlation was found between depth on one hand and germination percentage of tubers, length of shoots and numbers of leaves on the other hand. Germination of tubers was positively related to pH, dissolved oxygen, and the temperature of water. (Author's abstract)
W88-09997

FACTORS AFFECTING THE BENTHIC COMMUNITY STRUCTURE OF A DISCONTINUOUS STREAM IN GUADELUPE MOUNTAINS NATIONAL PARK, TEXAS,
Baylor Univ., Waco, TX. Dept. of Biology.
R. D. Meyerhoff, and O. T. Lind.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 3, p 283-296, 1987. 3 fig, 8 tab, 40 ref.

Descriptors: *Benthic fauna, *Benthic environment, *Interrupted streams, *Stream biota, *Ecosystems, *Macroinvertebrates, *Streams, Mountains, Biomass, Species Diversity, Population density, Guadelupe Mountains, Texas, Detritus.

McKittrick Creek, a discontinuous mountain stream in Guadelupe Mountains National Park, Texas, was sampled at discrete locations (pools) to test for differences in biomass, density, species diversity, equitability, and species richness in the benthic macroinvertebrate community. Significant differences occurred among pools for these biotic characteristics of the benthic community along the downstream gradient. Pools connected by flow were more similar to each other than pools separated by dry reaches. Variation in the quantity of coarse detritus and periphyton best explained differences among pools. (Author's abstract)
W88-09998

COMPARISON OF INSECT EMERGENCE FROM NATURAL AND ARTIFICIALLY MODIFIED SECTIONS OF A STREAM, THE FUHLENAU, IN SCHLESWIG-HOLSTEIN (VERGLEICHENDE EMERGENZSTUDIEN AN EINEM NATURNAHEN UND EINEM NATURFERNEN ABSCHNITT DES FLIESSGEWASSERSYSTEMS DER FUHLENAU, IN SCHLESWIG-HOLSTEIN),
Kiel Univ. (Germany, F.R.). Zoologisches Inst.und Museum.
K. Bottger, U. Holm, and K. Mikowski.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 3, p 339-368, 1987. 11 fig, 14 tab, 38 ref.

Descriptors: *Ecosystems, *Species diversity, *Channeling, *Streams, *Ecological effects, *Aquatic insects, *Stream improvement, *Insects, Benthos, Schleswig-Holstein, Federal Republic of Germany.

There are no detailed reports in the literature concerning the relationships between the degree to which artificial conditions along a stream have replaced natural ones and the zoobenthos colonization. The ecological effects of mechanical disturbances from channelization, maintenance, or similar activities are given as causes of reductions in individual abundances and species diversity. The ecological effects are essentially more complex and should be determined separately for each of the individual taxa. The conclusions are based on emergences recorded in traps during a six month period from May to October. (Author's abstract)
W88-09999

DETERMINATION OF BENTHIC-INVERTEBRATE INDICES AND WATER-QUALITY TRENDS OF SELECTED STREAMS IN CHESTER COUNTY, PENNSYLVANIA, 1969-80,
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 5A.
W88-10063

2I. Water In Plants

EFFECTS OF SHORT-TERM FLOODING ON GROWTH, YIELD, AND MINERAL COMPOSITION OF WHEAT ON SODIC SOIL UNDER FIELD CONDITIONS,
Central Soil Salinity Research Inst., Karnal (India).
D. P. Sharma, and A. Swarup.
Plant and Soil PLSOA2, Vol. 107, No. 1, p 137-143, March 1988. 2 fig, 6 tab, 21 ref.

Descriptors: *Flooding, *Flood damage, *Growth rates, *Alkaline soils, *Wheat, *Field tests, Oxygen uptake, Root development, Oxygen deficit, Limiting nutrients, Yield, Minerals, India, Alluvial plains, Soil types.

In sodic soils of the Indo-Gangetic alluvial plains of Northern India, flooding for short periods often occurs during the growing season of wheat, leading to low yields. A field study was therefore conducted to evaluate the effects of short-term flooding on growth, yield and mineral composition of wheat (Triticum aestivum Linn. emend. Fiori and Paol) in a sodic soil (pH 8.9, exchangeable sodium percentage 25). Flooding wheat for 2, 4, and 6 days at the time of first irrigation (25-day old plants), significantly reduced tillering, plant height, delayed head emergence and resulted in 17.6, 29.0 and 46.7 % reduction in grain yield, respectively. Flooding decreased oxygen diffusion rate (ODR) values, restricted root growth and reduced ion uptake, especially of N, P, K, Ca, Mg and Zn and led to higher absorption of Na, Fe and Mn. Under the conditions of this experiment, the reduced growth and yield of wheat resulting from short-term flooding was not due to Mn, Fe and Na toxicity but may be due to reduced uptake of nutrients resulting from O2 deficiency in the soil. (Author's abstract)
W88-09899

GERMINATION AND GROWTH OF POTAMOGETON PECTINATUS (L.) AT DIFFERENT WATER DEPTHS IN LAKE NAINITAL, UTTAR PRADESH, INDIA,
Kumaun Univ., Naini Tal (India). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W88-09997

SOMATIC CELL SELECTION CRITERIA FOR WATER USE EFFICIENCY USING GENETICALLY DIFFERENTIAL ALFALFAS,
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
For primary bibliographic entry see Field 3F.
W88-10021

MODELING OF SOIL WATER FLOW AND ROOT UPTAKE,
South Dakota State Univ., Brookings. Dept. of Plant Science.
For primary bibliographic entry see Field 2G.
W88-10076

2J. Erosion and Sedimentation

BUFFERING CAPACITY OF SOFT-WATER LAKE SEDIMENTS IN FLORIDA,
Minnesota Univ., Minneapolis. Dept. of Civil and Mining Engineering.
For primary bibliographic entry see Field 2H.
W88-08966

FLUVIAL PROCESSES IN RIVER ENGINEERING,
San Diego State Univ., CA.
For primary bibliographic entry see Field 2E.
W88-08990

GROUND WATER CONTAMINATION BY TOXIC SUBSTANCES: A CALIFORNIA ASSESSMENT,
California State Water Resources Control Board, Scaramento. Pollutant Investigations Branch.
For primary bibliographic entry see Field 5A.
W88-09116

SETTLING RATES OF PLUTONIUM-BEARING PARTICLES IN POND B,
Argonne National Lab., IL.
For primary bibliographic entry see Field 5B.
W88-09215

SEDIMENT INSTABILITY AND WOODY SEEDLING GROWTH,
For primary bibliographic entry see Field 5C.
W88-09224

SLOPE STABILITY: GEOTECHNICAL ENGINEERING AND GEOMORPHOLOGY.
For primary bibliographic entry see Field 8D.
W88-09334

MODELLING SLOPE STABILITY: THE COMPLIMENTARY NATURE OF GEOTECHNICAL AND GEOMORPHOLOGICAL APPROACHES,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 8D.
W88-09335

IMPLICATIONS OF JOINTS AND STRUCTURES FOR SLOPE STABILITY,
Leeds Univ. (England). Dept. of Earth Sciences.
For primary bibliographic entry see Field 8D.
W88-09339

GROUNDWATER MODELS FOR MOUNTAIN SLOPES,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 2F.
W88-09342

BASAL EROSION AND MASS MOVEMENT,
Cambridge Univ. (England). Dept. of Geography.
K. S. Richards, and N. R. Lorriman.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 331-357, 19 fig, 54 ref.

Descriptors: *Soil erosion, *Mass wasting, *Basal erosion, *Mass movement, *Slope stability, *Erosion, Weathering, Slope degradation, River valleys, Clay, Sediment erosion, Bank erosion, Pore water.

The major controls of slope instability and mass movement can be classified as passive or inherent (lithology, stratigraphy and structure, and topography), and active or initiating (loss of shear resistance because of weathering, and increased pore water pressure). Slopes being actively undercut by river or marine erosion can experience steepening slope angles or increased vertical extent at rates in excess of the rates of weathering or even pore pressure change, so that inherently unstable topographies can be actively generated. In this case clearly the critical active factor causing mass movement depends on relative rates of basal erosion and weathering. The role of slope-foot conditions in relation to slope development has been demonstrated particularly in the context of declining slope angles associated with the withdrawal of basal removal processes. These mechanisms of slope angle decline after withdrawal of basal erosion are not entirely irrelevant to the case of active basal erosion, since this is rarely a continuous process. Between major slope failure events the slope foot is protected by failed debris in which strength and pore water adjustments occur, and the next major failure, therefore, awaits removal of this material. Slope or cliff recession under conditions of active but intermittent basal erosion is continuous in the long- and short-term behavior, and the cyclic process of failure and temporary stabilization, both vary with the efficiency of basal erosion and with the stratigraphy and lithology of the eroded slope. Four distinctive sets of conditions are discussed in order of progressively increasing basal erosion rates: (1) slow basal erosion in river valleys; (2) moderate to rapid basal erosion of overconsolidated clay cliffs; (3) rapid basal erosion in quaternary sediments; and (4) undermining and collapse of steep composite banks. (See also W88-09334) (Lantz-PTT)
W88-09344

WEATHERING EFFECTS: SLOPES IN MUDROCKS AND OVER-CONSOLIDATED CLAYS,
Durham Univ. (England). School of Engineering and Applied Science.
R. K. Taylor, and J. C. Cripps.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 405-445, 13 fig, 5 tab, 114 ref.

Descriptors: *Erosion, *Slope stability, *Weathering, *Clay, *Mud, Soil erosion, Disintegration, Pyrite, Oxidation, Permafrost, Pore pressure, Shear strength.

Although the majority of (pedological) soil types can develop on almost any mudrock or clay, slope formation entails a complex interaction of weathering and deformational processes. These processes can best be illustrated by weathering profiles in which an argillaceous character is retained throughout. Similarly, failure mechanisms of man-made cuttings in clay help in understanding the evolution of natural slopes. The following factors would seem to be relevant to the relationship between weathering and slope formation: (1) Diagenetic changes which occur as a consequence of depth of burial generally impart an overall resistance to weathering; (2) Weathering is the converse of diagenesis. It is initiated by natural processes of uplift and erosion or in excavations made by man; (3) Physical disintegration (weathering) is more rapid than chemical weathering. It increases the surface area available for chemical reactions and consequently acts as a control on the latter; (4) Indurated mudrocks undergo a far greater degree of disintegration, to produce a wider range of particle sizes, than more weakly bonded clays; (5) The oxidation of pyrite, FeS2 (when present), is probably of greater significance than the dissolution of calcite cement in chemical weathering. Other carbonates in mudrocks are relatively more resistant to chemical breakdown than calcite; (6) Apart from deposits which have been thoroughly reworked by surface erosion, solifluction, or possibly permafrost, weathering profiles in the UK indicate only minor formation of further (secondary) expandable clay minerals by acid weathering; (7) Reduced pore pressures and swelling are further effects of unloading; (8) Weathering schemes are used for comparative purposes in mudrocks; (9) Progressive failure is a complex load-shedding mechanism. Discontinuities may be exploited to act as stress concentrators, as well as helping to reduce the strength of the mass, and more locally, in causing softening as part of general weathering processes; and (10) Clearly the role of mass instability in slope development depends on the rates at which both slope steepening processes and weathering-induced softening operate, as well as other factors including piezometric pressures. (See also W88-09334) (Lantz-PTT)
W88-09347

MASS MOVEMENT IN SEMI-ARID ENVIRONMENTS AND THE MORPHOLOGY OF ALLUVIAL FANS,
Minnesota Univ., Minneapolis. Dept. of Geology and Geophysics.
R. L. B. Hooke.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 505-529, 11 fig, 50 ref.

Descriptors: *Mass wasting, *Semiarid lands, *Mass movement, *Alluvial fans, *Geomorphology, *Sediment transport, Land forming, Debris flows, Debris cone.

Although there are a number of constructional landforms in semi-arid regions, alluvial fans and associated features are the most important, volumetrically, in most such environments. Furthermore, with the possible exception of the grain flows that characterize the slip-faces of sand dunes, alluvial fans are the only constructional landform on which mass movements play an important role. Of the various mass movement processes that occur on fans, debris flows are the most significant. Their importance, however, varies with climate and lithology. They tend to be more common, relative to fluvial events, in drier watersheds with less vegetation and in watersheds underlain by rock types that produce more fine material upon weathering. Many debris-flow deposits, however, are subsequently modified by fluvial processes so their origin is difficult to establish. Thus beds that are demonstrabaly of debris-flow origin usually comprise less than a quarter of the material in fans, and the dominant surface features on fans, and the dominant surface features on fans are of fluvial origin. If the process by which any given particle was transported to a fan could be determined, however, debris flows would be found to be more important. Two other mass-movement processes that operate on fans are grain flows associated with sieve deposition and creep which leads to development of desert pavements. Neither is especially important in terms of the volume of material moved, but the degree of creep smoothing of a fan surface provides one criterion upon which relative age assignments can be based when mapping fans. (See also W88-09334) (Lantz-PTT)
W88-09349

MECHANISMS OF MASS MOVEMENT IN PERIGLACIAL ENVIRONMENTS,
University Coll., Cardiff (Wales). Dept. of Geology.
C. Harris.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 531-559, 18 fig, 136 ref.

Descriptors: *Mass movement, *Frozen ground, *Mass wasting, *Periglacial environment, *Permfrost, *Slope stability, Thawing, Freezing, Ice, Pore water, Landslides, Rainfall.

The most important aspect of periglacial slopes formed in unconsolidated soils is the present of ice-rich frozen ground. Thawing of such frozen ground is liable to release excess water and promote significant loss of strength in the newly thawed soil as normal stresses are transferred to the pore water during consolidation. Mass movements on very gentle slopes may result. Solifluction represents the annual, widespread, slow, mass movement of the active layer during thaw. Sporadic localized failures producing rapid flows and slides are generally superimposed on slopes suffering some degree of solifluction. They usually result from accelerated thawing initiated by such events as abnormally high temperatures, high rainfall, or fire. The susceptibility of periglacial slopes to thaw-induced instability is of particular concern to engineers, especially where engineering works may disturb the thermal equilibrium of ice-rich permafrost. Careful terrain analyses are therefore necessary in advance of more detailed site investigations. It is in this field of terrain evaluation that the most obvious practical interaction between engineers and geomorphologists takes place. (See also W88-09334) (Lantz-PTT)
W88-09350

SLOPE DEVELOPMENT THROUGH THE THRESHOLD SLOPE CONCEPT,
For primary bibliographic entry see Field 8D.
W88-09351

KARST GEOMORPHOLOGY,
Australian National Univ., Canberra.
For primary bibliographic entry see Field 8E.
W88-09352

MORPHOLOGICAL RESPONSES AND SEDIMENT PATTERNS,
Polytechnic Wolverhampton (England). School of Applied Sciences.
For primary bibliographic entry see Field 2E.
W88-09369

LONG-TERM SEDIMENT STORAGE IN THE SEVERN AND WYE CATCHMENTS,
Leicester Univ. (England). Dept. of Geography.
A. G. Brown.
IN: Palaeohydrology in Practice: A River Basin Analysis. John Wiley and Sons, New York. 1987. p 307-332, 8 fig, 3 tab, 57 ref.

Descriptors: *Sediment yield, *Holocene, *Sediment storage, *Severn River, *Wye River, *Paleohydrology, *Geomorphology, *Sediment transport, Catchment areas, Flood plains, Embankments, Erosion, Sedimentation, United Kingdom, Canalization, Channelization, Geohydrology, Flooding.

Traditional views of drainage-basin dynamics tend to emphasize the erosional component of the upland headwaters and the transportational role of the middle zones. However, estimated sediment delivery ratios and the importance of the storage

element in the middle and lower zones of basins indicate that, in time, these zones can become foci of remobilized sediment from stores of different residence times. The length of time involved is depends hydrological and geomorphological conditions and their modification by man. Embankment has also led to a reduction in flooding and presumably to a decrease in floodplain accumulation rates but an increase in within-channel sedimentation, especially in lower reaches. The quantities of stored sediment in lowland basins such as that of the Severn, in relation to present sediment yields, suggest that man altered the relationships between the erosion, transport and storage processes during the Mid- and Late-Holocene. In the process deep and fertile or potentially fertile, alluvial and colluvial soils have been created. Quantification of sediment budgets requires the identification of sources and stores, and the determination of transport rates and residence times. Radiometric dating can provide the residence times and rates but the extent of the sediment stores in the Severn Basin is poorly known. Calculations based on these rates suggest that as much sediment has gone into storage as has left the Severn and Wye basins during the Holocene. The storage component is not spatially uniform and in particular it is likely that the majority of hillslope erosion went into proximal colluvial storage. (See also W88-09360) (Lantz-PTT)
W88-09371

HISTORY OF PALEOFLOOD HYDROLOGY IN THE UNITED STATES, 1800-1970,
Cascades Volcano Observatory, Vancouver, WA.
For primary bibliographic entry see Field 2E.
W88-09407

MEASURING THE RIVERS OF THE PAST: A HISTORY OF FLUVIAL PALEOHYDROLOGY,
Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.
For primary bibliographic entry see Field 2E.
W88-09408

HISTORY OF THOUGHT ON THE ORIGIN OF SUBSURFACE SEDIMENTARY BRINES,
Louisiana State Univ., Baton Rouge. Dept. of Geology.
For primary bibliographic entry see Field 2K.
W88-09411

ABANDONED MINES IN ILLINOIS AND NORTH DAKOTA: TOWARD AN UNDERSTANDING OF REVEGETATION PROBLEMS,
Illinois Natural History Survey, Champaign.
For primary bibliographic entry see Field 4C.
W88-09451

ROLE OF SEDIMENT IN THE PERSISTENCE AND TRANSPORT OF ENTERIC VIRUSES IN THE ESTUARINE ENVIRONMENT,
University of Southern Mississippi, Hattiesburg. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W88-09466

VIRUS ASSOCIATION WITH SUSPENDED SOLIDS,
Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
For primary bibliographic entry see Field 5B.
W88-09467

EFFECTIVE DISCHARGE FOR SUSPENDED SEDIMENT TRANSPORT IN STREAMS OF THE SASKATCHEWAN RIVER BASIN,
Saskatchewan Univ., Saskatoon. Dept. of Geography.
P. E. Ashmore, and T. J. Day.
Water Resources Research WRERAO, Vol. 24, No. 6, p 864-870, June 1988. 3 fig, 1 tab, 12 ref.

Descriptors: *Sediment transport, *Erosion, *Streams, *Discharge hydrographs, *Sediment discharge, Saskatchewan River, Flow discharge, Hydrographs.

Effective discharge for suspended sediment load was determined for 21 sites in the Saskatchewan River basin at which sediment records range from 5 to 29 years in length. The drainage areas of these streams range from 10 to 347,000 sq km. The sediment discharge histograms showed a variety of forms, which were placed in five groups: (1) the classic unimodal form in which the peak occurs at discharges with a duration of 1-3%; (2) very erratic form and discharges of widely differing durations transporting similar sediment loads (all small drainage basins with a single, sharp snowmelt peak); (3) the effective discharge is the extreme event of record; (4) similar to group 3 but dominated by the events at the upper end of the discharge range (sometimes the largest daily flow on record was the effective discharge); and (5) single mode occurring at a discharge with a duration similar to those in the first group but in which the histogram has a broad, almost flat peak covering a wide discharge range. The percentage duration of effective discharge varied from nearly zero to 47.54 (seasonal basis) with most in the 1-10% range. The percentage duration of effective discharge was related to the drainage area of the streams, perhaps reflecting differences in the form of the discharge duration curves. The smaller headwaters basins in the Rocky Mountains and foothills tended to be dominated by the most extreme events, while the large prairie rivers with mountain sources were dominated by frequent events with durations often greater than 10%. Thus percentage duration of the effective discharge tended to increase downstream. (Cassar-PTT)
W88-09544

MUNICIPAL LAND USE REGULATION AND THE GREAT LAKES SHORELINE HAZARD IN ONTARIO,
Guelph Univ. (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 6F.
W88-09547

ALGAL REMAINS IN SOME SURFACE SEDIMENTS OF LAKE ERIE,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 2H.
W88-09550

FACTORS AFFECTING METAL PARTITIONING DURING RESUSPENSION OF SEDIMENTS FROM THE DETROIT RIVER,
Clarkson Univ., Potsdam, NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W88-09555

CHARACTERIZATION OF SEDIMENTARY HUMIC ACIDS FRACTIONATED BY HYDROPHOBIC INTERACTION CHROMATOGRAPHY,
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. de Biologie Appliquee.
For primary bibliographic entry see Field 2L.
W88-09560

FACIES AND GEOMETRY OF AN ESTUARINE BAR AND CHANNEL SYSTEM,
Bordeaux-3 Univ., Talence (France). Inst. de Geodynamique.
For primary bibliographic entry see Field 2L.
W88-09562

ANALYSIS OF POLYCYCLIC AROMATIC HYDROCARBONS IN LACUSTRAL SEDIMENTS BY HIGH RESOLUTION SHPOL'SKII SPECTROFLUORIMETRY AT 10 K,
Universite de Savoie, Chambery (France). Lab. de Spectroscopie Moleculaire.
For primary bibliographic entry see Field 5A.
W88-09579

EFFECTS OF ACID PRECIPITATION ON SEDIMENT DOWNCORE PROFILES OF DIATOMS, BACTERIAL DENSITIES AND SULPHUR ISOTOPE RATIOS IN LAKES NORTH OF LAKE SUPERIOR,
McMaster Univ., Hamilton (Ontario). Dept. of Chemistry.
For primary bibliographic entry see Field 5C.
W88-09592

EFFECTS OF FLOODING AND SEDIMENTS ON THE STRUCTURE OF A STREAM MIDGE ASSEMBLAGE,
Ohio Univ., Athens.
For primary bibliographic entry see Field 2H.
W88-09619

CHANGES IN THE PHYSICAL AND CHEMICAL PROPERTIES OF FLOODWATER AND SEDIMENT IN AN EXPERIMENTAL RICE-FIELD (REGGIO EMILIA, ITALY),
Parma Univ. (Italy). Ist. di Ecologia.
For primary bibliographic entry see Field 2H.
W88-09624

TRANSPORT OF FINE-GRAINED SEDIMENTS IN SHALLOW WATERS,
California Univ., Santa Barbara. Dept. of Mechanical and Environmental Engineering.
C. K. Ziegler, and W. Lick.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 123-132, February 1988. 7 fig, 16 ref.

Descriptors: *Sediment transport, *Sedimentation rates, *Model studies, *Rivers, *Mathematical models, Sediments, Sediment distribution, Suspension, Resuspension, Deposition, Bottom sediments, Mathematical equation, Mathematical studies, Differential equations, Raisin River, Mathematical models, Estuaries, Deltas.

A numerical model of the resuspension, deposition, and transport of fine-grained, cohesive sediments was developed and applied. An essential part of this model is an accurate and physically realistic description of the sediment bed and the resuspension of the bottom sediments due to physical processes. The description is based on data from recent experimental and field work on fine-grained sediments. Pertinent results from this work were incorporated into the present model, and as part of the calculation, changes in the resuspension properties of the sediment bed with time due to resuspension, deposition, and compaction can be approximately determined. Vertically integrated differential equations were used to approximate the hydrodynamic and sediment transport equations. A volume integral method was used to derive finite difference equations which are second-order accurate, explicit, and locally conservative. A unique feature of the numerical model is that it can successfully treat conditions at open boundaries where both incoming and outgoing waves or disturbances may be present. The model was applied to the resuspension, deposition, and transport of fine-grained sediments in (1) the Raisin River, a small polluted stream flowing into Lake Erie; (2) a river flowing into a lake or ocean with a cross-flow; and (3) a time-dependent flow in a simple estuary as affected by tidal currents. The formation of erosional and depositional areas under various conditions is demonstrated. (Author's abstract)
W88-09710

SEDIMENTARY SULFIDE IN THE NEARSHORE GEORGIA BIGHT,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE. Haskell Lab. for Toxicology and Industrial Medicine.
For primary bibliographic entry see Field 2L.
W88-09711

EFFECT OF BIOLOGICAL AND PHYSICAL DISTURBANCES ON THE TRANSPORT OF ARSENIC FROM CONTAMINATED ESTUARINE SEDIMENTS,
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 5B.

W88-09716

CHANNEL RESPONSE TO GRADE-CONTROL STRUCTURES ON MUDDY CREEK, MISSISSIPPI,
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
For primary bibliographic entry see Field 8B.
W88-09719

SUSPENDED SOLIDS TRANSPORT IN THE REGULATED RIVER BLITHE, STAFFORDSHIRE, U.K.,
Birmingham Univ. (England). Dept. of Geological Sciences.
D. J. Gilvear.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 117-129, April-June 1988. 8 fig, 4 tab, 25 ref.

Descriptors: *Suspended solids, *Sediment transport, *Water management effects, *Dam effects, Environmental effects, Dams, Reservoirs, Turbidity, Monitoring, Flood frequency, Flooding, River Blithe, England, Suspended load, Resuspension, Sediments, Seston, Hysteresis.

Suspended solids concentrations and turbidity were monitored on the regulated River Blithe at two sites downstream of the reservoir for a period of 18 months. Changes in the suspended solids loads transported and the nature of the material in suspension were related to dam overspill and tributary flood events. A hysteretic relationship between suspended solids concentrations and discharge was characteristic of both sites, sediment supply being limited within the regulated river. Impoundment of the river resulted in a reduction of the frequency and magnitude of floods and a concomitant increase in clearwater flows; the hydrological effects are greatest close to the dam but evident the entire length of the river. Downstream of the dam, rapid bank erosion occurred on meander bends but the suspended solids loads transported by the regulated river relate more to the resuspension and transport of tributary injected sediments and scouring of a dense periphyton. Close to the dam, fine biogenic matter dominated the seston, which scanning electron microscopy revealed to contain algal fragments and inorganic diatom frustules, but downstream, tributary-derived minerogenic particles were dominant. (Wood-PTT)
W88-09722

ACCUMULATION OF FINE SEDIMENT WITHIN SUBSTRATE GRAVELS ALONG TWO REGULATED RIVERS, UK,
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 6G.
W88-09724

MONITORING THE IMPACT OF DAMS ON THE DOWNSTREAM PHYSICAL ENVIRONMENT IN THE TROPICS,
Bayero Univ., Kano (Nigeria). Dept. of Geography.
For primary bibliographic entry see Field 6G.
W88-09726

EFFECT OF TUBIFICIDS AND CHIRONOMIDS ON PARTICLE REDISTRIBUTION OF LAKE SEDIMENT,
Niigata Univ. (Japan). Biological Lab.
H. Fukuhara.
Ecological Research, Vol. 2, No. 3, p 255-264, December 1987. 5 fig, 1 tab, 29 ref.

Descriptors: *Bioturbation, *Limnology, *Aquatic animals, *Midges, *Tubificids, *Lake sediments, *Sediments, Particle size, Feeding rates, Aquatic plants, Diatoms, Paleolimnology, Cyanophyta.

The effects of chironomid larvae, Chironomus plumosus, and tubificid worms, Limnodrilus spp., on particle redistribution in lake sediments were investigated experimentally, using pots containing sediments obtained from Lake Suwa, Japan. The chironomids and tubificids increased the water content of surface sediments. The chironomid larvae had no effect on particle size distribution, while tubificids continuously accumulated small particles on the surface sediment through their selective feeding activity. Particles > 0.125 mm were buried at a sediment depth of 6 cm. In Lake Suwa, long diatom frustules, large plant debris and blue-green algal flocs accumulated in the deeper layer of the lake sediment inhabited by tubificids at high density. (Author's abstract)
W88-09772

GEOCHEMICAL STUDY OF WEATHERING THROUGH CHEMICAL COMPOSITION IN NATURAL WATERS,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 2K.
W88-09804

LABORATORY STUDIES ON CORE SAMPLING WITH APPLICATION TO SUBTIDAL MEIOBENTHOS COLLECTION,
Louisiana State Univ., Baton Rouge. Dept. of Zoology and Physiology.
For primary bibliographic entry see Field 7B.
W88-09847

SUBSIDENCE IN THE NORTHEASTERN NILE DELTA: RAPID RATES, POSSIBLE CAUSES, AND CONSEQUENCES,
Smithsonian Institution, Washington, DC. Mediterranean Basin Project.
D. J. Stanley.
Science SCIEAS, Vol. 240, No. 4851, p 497-500, April 22, 1988. 3 fig, 1 tab, 31 ref.

Descriptors: *Subsidence, *Nile Delta, *Geomorphology, *Deltas, *Geologic history, *Geologic mapping, River mouth, Sea level, Flooding, River forecasting, Sedimentation rates.

Holocene fluvial and marine deposits have accumulated in a graben-like structure on the northeastern margin of the Nile delta. This part of the delta, which includes Lake Manzala, Port Said, and the northern Suez Canal, has subsided rapidly at rates of up to 0.5 centimeters per year since about 7500 years ago. This subsidence has diverted at least four major distributaries of the Nile River into this region. The combined effects of continued subsidence and sea level rise may flood a large part of the northern delta plain by as much as 1 meter by the year 2100. The impact of continued subsidence, now occurring when sediment input along the cost has been sharply reduced because of the Aswan High Dam, is likely to be substantial, particularly in the Port Said area and as far inland as south of Lake Manzala. (Author's abstract)
W88-09901

ORGANIC MATTER CONTENT IN SEDIMENTS OF THREE NAVIGATION POOLS ALONG THE UPPER MISSISSIPPI RIVER,
For primary bibliographic entry see Field 2H.
W88-09932

SEDIMENT DISCHARGE IN MUDDY CREEK AND THE EFFECT OF SEDIMENTATION RATE ON THE PROPOSED WOLFORD MOUNTAIN RESERVOIR NEAR KREMMLING, COLORADO,
Geological Survey, Denver, CO. Water Resources Div.
B. C. Ruddy.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources Investigations Report 87-4011, 1987. 22 p, 11 fig, 3 tab, 9 ref.

Descriptors: *Suspended load, *Bed load, *Reservoir sedimentation, *Silting, *Colorado, Hydrologic data.

Stream-discharge data collected from May 1982 through October 1985 and sediment data collected from March 1985 through October 1985 at stream flow-gaging station 09041500 Muddy Creek at Kremmling, Colorado, were used to determine total-sediment discharge into the proposed Wolford Mountain Reservoir. The data were divided on a seasonal basis, and statistical relations between suspended-sediment discharge and stream discharge were determined for the rising stage, falling stage, and base-flow period. One statistical relation between bedload discharge and stream discharge was determined from all collected data. These relations were used with 3 years of daily stream-discharge data to estimate total-sediment discharge. Total-sediment discharge was largest prior to the annual peak stream discharge during the study period and decreased thereafter. At least 97% of the total-sediment discharge was suspended sediment. Mean annual total-sediment discharge in Muddy Creek near Kremmling was estimated to be 83,000 tons per year for the 1983 through 1985 water years. Water-storage capacity of the proposed Wolford Mountain Reservoir at site C would decrease 10% after 100 years at this rate of mean annual total-sediment discharge. (USGS)
W88-10065

HYDRAULICS AND BED MATERIAL TRANSPORT AT HIGH FINE SUSPENDED SEDIMENT CONCENTRATIONS,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
J. B. Bradley.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8618167. Ph.D Dissertation, 1986. 140 p, 32 fig, 11 tab, 93 ref.

Descriptors: *Suspended sediments, *Sediment transport, *Streamflow, *Sediment concentration, *Hydraulics, *Flow characteristics, Turbulent flow, Mathematical analysis, Laminar flow, Mudflows, Flumes, Flow velocity, Flow resistance.

Steady uniform flow in a two-foot wide flume was studied in a laboratory using a clay washload and sand bed, and field measurements of high sediment concentration flows were collected. The adequacy was evaluated of extending methodologies for turbulent low concentration flows, such as the logarithmic-velocity distribution, related resistance equations, the Rouse equation, and existing sediment transport formulas, to high concentration flows. In fixed bed runs, vertical sand distributions were supply limited and uniform for both turbulent hyperconcentrated and laminar mud flows. Mobile dune and plane bed runs had comparable Z values for measured and computed cases in turbulent hyperconcentrated flows. Computed values were developed from the Rouse equations using a modified fall velocity to reflect changes in fluid properties. Deviation to a more vertically uniform profile was observed at higher concentrations of hyperconcentrated and mud flows. Bed material transport rates for similar hydraulic conditions were much larger in flows with fine sediment concentrations. (Cremmins-AEPCO)
W88-10085

2K. Chemical Processes

SOURCES AND FATES OF AQUATIC POLLUTANTS.
For primary bibliographic entry see Field 5B.
W88-09065

METHODS FOR ESTIMATING SOLUBILITIES OF HYDROPHILIC ORGANIC COMPOUNDS: ENVIRONMENTAL MODELING EFFORTS,
Wisconsin Univ.-Madison. Water Chemistry Program.
For primary bibliographic entry see Field 5B.
W88-09066

VAPOR-PARTICLE PARTITIONING OF SEMIVOLATILE ORGANIC COMPOUNDS,
South Carolina Univ., Columbia. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.

W88-09067

AIR-SEA TRANSFER OF TRACE ELEMENTS,
Rhode Island Univ., Kingston. Graduate School of Oceanography.
For primary bibliographic entry see Field 5B.
W88-09070

METAL SPECIATION IN NATURAL WATERS: INFLUENCE OF ENVIRONMENTAL ACIDIFICATION,
Quebec Univ., Sainte-Foy.
For primary bibliographic entry see Field 5C.
W88-09072

ION BUDGETS IN A SEEPAGE LAKE,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2H.
W88-09073

MECHANISMS OF ALKALINITY GENERATION IN ACID-SENSITIVE SOFT WATER LAKES,
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
For primary bibliographic entry see Field 5C.
W88-09074

CYCLES OF NUTRIENT ELEMENTS, HYDROPHOBIC ORGANIC COMPOUNDS, AND METALS IN CRYSTAL LAKE,
Wisconsin Univ.-Madison. Water Chemistry Program.
For primary bibliographic entry see Field 5B.
W88-09080

ELEMENT CYCLING IN WETLANDS: INTERACTIONS WITH PHYSICAL MASS TRANSPORT,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W88-09081

ALTERNATIVE WELL SEAL IN HIGHLY MINERALIZED GROUND WATER,
For primary bibliographic entry see Field 7B.
W88-09156

BACKGROUND GROUND-WATER QUALITY MONITORING: WELL INSTALLATION TRAUMA,
Jordan Gorrill Associates, Portland, ME.
For primary bibliographic entry see Field 7B.
W88-09157

TECHNIQUE FOR RENOVATING CLOGGED MONITOR WELLS,
For primary bibliographic entry see Field 7B.
W88-09158

BORE-VOLUME PURGING TO IMPROVE MONITORING WELL PERFORMANCE: AN OFTEN-MANDATED MYTH,
For primary bibliographic entry see Field 7B.
W88-09159

LABORATORY INVESTIGATION OF THE PURGING BEHAVIOR OF SMALL-DIAMETER MONITORING WELLS,
For primary bibliographic entry see Field 7B.
W88-09160

GEOCHEMISTRY OF NATURAL WATERS,
Wyoming Univ., Laramie.
J. I. Drever.
Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 1982. 388 p.

Descriptors: *Geochemistry, *Water chemistry, *Hydrologic systems, Chemical properties, Streams, Hydrological regime, Lakes, Groundwater, Ecological effects, Ecosystems, Rain, Erosion, Solute transport, Mathematical studies, Weathering, Oceans.

Water is an essential part of the geological cycle. Rain water converts the granitic rocks of the continents to clay, sand, and solutes, and transports them to the ocean where they become the raw material of future continents. To understand this fundamental cycle, one must understand how rocks weather, and how the solutes removed during weathering becomes reincorporated into solid phases to form the next generation of rocks. This books is written to inform the reader of the present state of knowledge of the processes controlling the composition of natural waters - streams, lakes, the ocean, and near-surface groundwaters. Although many examples of human influence are discussed, the primary objective is to document how the natural systems work. This provides a framework in which to discuss the consequences of human activities, and the processes operating in natural systems are often the same as the processes operating in polluted or otherwise disturbed waters. The approach used, wherever possible, is to discuss specific studies of natural waters rather than to present theory in an abstract way. Chemical and mathematical presentation is kept simple, and geologic terms that might be unfamiliar are explained in the glossary. (Lantz-PTT)
W88-09235

EARLY TWENTIETH-CENTURY INVESTIGATIONS OF THE RADIOACTIVITY OF WATERS IN NORTH AMERICA,
Geological Survey, Reston, VA.
E. R. Landa.
IN: The History of Hydrology. American Geophysical Union, Washington, DC. 1987. p 75-80, 3 fig, 41 ref.

Descriptors: *Geophysics, *Geochemistry, *Radioactivity, *History, *Radioactive springs, Uranium, Radon, Radium, Mineral springs, Springs.

The first investigations of radioactivity in surface and groundwaters in North America were sparked in 1903 by a visit to Yale University from a Cambridge University professor, J. J. Thomson. Impetus for continuing studies was provided by a general interest in the phenomenon of radioactivity and by medical and commercial interest in the alleged therapeutic value of radioactive substances in water. Measurement methodology was given much attention. Attempts were made to correlate radioactivity with lithology and readily measurable water properties such as temperature and total dissolved solids, generally with little success. However, information was obtained on some important hydrogeochemical properties of the naturally occurring radionuclides, including the differing mobilities of the chemically distinct members of the uranium decay series and the coprecipitation behavior of radium. Radioactivity in water was expressed in terms of a variety of units: grams of radium, grams of uranium, curies, mache units, and emans. (See also W88-09405) (Cassar-PTT)
W88-09410

HISTORY OF THOUGHT ON THE ORIGIN OF SUBSURFACE SEDIMENTARY BRINES,
Louisiana State Univ., Baton Rouge. Dept. of Geology.
J. S. Hanor.
IN: The History of Hydrology. American Geophysical Union, Washington, DC. 1987. p 81-91, 11 fig, 44 ref.

Descriptors: *Geohydrology, *Geophysics, *Geochemistry, *Saline water, *Brines, *History, Salt deposits, Membrane processes, Infiltration, Evaporite, Solubility, Subsurface water, Springs, Connate water, Seawater, Chlorides, Evaporation, Dissolution, Solute transport, Rivers, Fermation water.

The remains of ancient salt works around brine seeps stand as evidence that Prehistoric man not only knew that some groundwaters are salty, but took commercial advantage of this resource. Pre-Socratics, such as Anaxagoras (ca. 450 B.C.), speculated that the surface waters of the earth were derived by evaporation of subsurface waters, a process which could leave a salty residue. Lucretius (ca 60 B.C.) advocated a subterranean filtering out of brine as seawater was cycled back from the oceans into the continents to form fresh water springs and rivers. Medieval and Renaissance cosmologists also believed in the subterranean cycling of seawater, but more often called upon distillation as a means for removing salt. The body of knowledge concerning brines improved in the late 1600s as drilling and mining activities established the spatial proximity of some brine springs with bedded rock salt. It was generally believed by the early 1800s that brines resulted from the subsurface dissolution of salt. In 1859, T.S. Hunt proposed that subsurface salty waters are actually fossil seawater and that the elevated Ca to Na ratio in these pore fluids reflects an elevated calcium concentration in ancient oceans. Thus was born the notion of a connate origin for formation waters. Much of the current thought regarding the origin of brines has come from the study of waters coproduced with oil and gas. The most popular brine-forming mechanism of the early 20th century, subsurface evaporation of pore water into a methane gas phase, was shown by Russell on mass-balance grounds in 1933 to be impossible. Most discussion today centers on one or more of the following mechanisms: membrane filtration (compacted clays and shales serving as membranes), infiltration of subaerial brines, and subsurface dissolution of evaporites. (See also W88-09405) (Author's abstract)
W88-09411

INTERCALIBRATION EXERCISE FOR TRACE METALS IN MARINE SEDIMENTS,
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 5A.
W88-09559

CHARACTERIZATION OF SEDIMENTARY HUMIC ACIDS FRACTIONATED BY HYDROPHOBIC INTERACTION CHROMATOGRAPHY,
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. de Biologie Appliquee.
For primary bibliographic entry see Field 2L.
W88-09560

SINGLET OXYGEN ANALYSIS IN IRRADIATED SURFACE WATERS,
Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Chimie Physique.
For primary bibliographic entry see Field 7B.
W88-09569

GEOCHEMICAL ANALYSIS OF RIYADH GROUND WATER,
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Physics.
A. Naeem.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 3, p 161-170, February 1987. 3 fig, 3 tab, 8 ref.

Descriptors: *Heavy metal, *Water quality, *Water analysis, *Groundwater, *Saudi Arabia, *Geochemistry, *Aquifers, Neutron activation analysis, Riyadh region, Iron, Copper, Nickel, Arsenic, Selenium, Bicarbonates, Calcium, Magnesium, Sodium, Chloride, Sulfates, Potassium, Cadmium, Lead, Jubaila aquifers, Public health, Drinking water, Water treatment, Meteoric water, Seawater.

This paper presents a geochemical study of Riyadh groundwater from Minjar and Jubaila aquifers near Riyadh region in Saudi Arabia. The concentrations of Fe, Cu, and Ni and the potentially toxic elements such as As, Cd, Pb and Se were less than 0.01 ppm. These waters contain Ca(++), Mg(++), Na(+), CL(-) and SO4(--) in higher concentrations than K(+) and HCO3(-). The concentration of all the elements detected in these waters is within the maximum permissible limits

suggested by various world health organizations. The waters from the Minjur and Jubaila aquifers are of SO4-Mg and Cl-Ca type, respectively, and are believed to be a mixture of marine and meteoric genesis. These waters are suitable for drinking after some softening and desalination treatment. (Author's abstract)
W88-09578

TEST SYSTEM FOR THE DETERMINING OF THE FATE OF PESTICIDES IN SURFACE WATER: PROTOCOL AND COMPARISON OF THE PERFORMANCE FOR PARATHION OF ECOCORES AND MICRO ECOSYSTEMS FROM TWO SOURCES,
Institute for Pesticide Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 5A.
W88-09584

ANALYTICAL CHEMISTRY OF CHROMIUM SPECIES IN THE ENVIRONMENT, AND INTERPRETATION OF RESULTS,
Bayer A.G., Leverkusen (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W88-09589

MANGANESE IN DRINKING WATER OF THE TOWN OF BEAUCAIRE: ORIGINS AND SOLUTIONS (MANGANESE DANS L'EAU D'ALIMENTATION DE LA VILLE DE BEAUCAIRE: ORIGINES ET SOLUTIONS),
Aix-Marseille-1 Univ. (France). Lab. de Chime Generale.
For primary bibliographic entry see Field 5B.
W88-09597

MULTICOLUMN ION CHROMATOGRAPHIC DETERMINATION OF NITRATE AND SULFATE IN WATERS CONTAINING HUMIC SUBSTANCES,
Lund Univ. (Sweden). Dept. of Analytical Chemistry.
For primary bibliographic entry see Field 7B.
W88-09608

2-(5-BROMO-2-PYRIDYLAZO)-5-DIMETHYLAMINOPHENOL (5-BR-DMPAP) AS A REAGENT FOR SPECTROPHOTOMETRIC DETERMINATION OF IRON(III),
Environmental Science Research Inst. of Guanzhou Prefecture, Ganzhou (China).
For primary bibliographic entry see Field 7B.
W88-09612

INTERACTION OF CERTAIN HEAVY METALS WITH LAKE HUMIC ACIDS,
Kashmir Univ., Srinagar (India). Centre of Research for Development.
For primary bibliographic entry see Field 2H.
W88-09613

CONSEQUENCES OF REDOX CONDITIONS ON THE DISTRIBUTION OF CATIONS IN A MEROMICTIC OLIGOTROPHIC LAKE,
Clermont-Ferrand-2 Univ., Aubiere (France).
For primary bibliographic entry see Field 2H.
W88-09623

FRESH WATERS OF SHETLAND: CHEMICAL CHARACTERISTICS OF RUNNING WATERS,
Institute of Terrestrial Ecology, Edinburgh (Scotland).
K. H. Morris.
Hydrobiologia HYDRB8, Vol. 144, No. 3, p 211-221, January 30, 1987. 3 fig, 3 tab, 34 ref.

Descriptors: *Water chemistry, *Geochemistry, *Shetland Islands, United Kingdom, Multivariate analysis, Synoptic analysis, Altitude, Stream classification, Tributaries, Catchment areas, Physical properties, Hydrogen ion concentration, Conductivity, Alkalinity, Sodium, Potassium, Calcium, Magnesium, Phosphorus, Nitrogen, Organic carbon, Suspended solids, Color, Iron, Silicon, Nickel, Chromium, Copper, Geology, Peat, Prediction, Maps, Acid streams, Running waters, Chemical properties, Acid rain effect.

The water chemistry of 48 streams on the Shetland Islands was determined as part of a synoptic survey of the islands during 1974. For each point of intersection of a stream with a 1 km grid line on a map of the islands, fourteen stream and catchment parameters were measured from the map: altitude, slope, stream order, whether a tributary or direct to the sea, distance from the sea, highest point in the catchment, catchment area, and catchment characteristics. Each of 54 running-water sites was visited on several occasions during the spring and summer of 1974 when physical measurements and biological and chemical samples were taken; these samples were analyzed for pH, conductivity, alkalinity, Na, K, Ca, Mg, P, ammonium N, nitrate N, dissolved organic carbon, % total suspended solids, Hazen (color), Fe, reactive Si, Ni, Cr, and Cu. Principal-component analysis identified three main contributors to stream chemistry: solid geology, drift geology (in the form of peat), and marine influence. The sites could be clustered by their chemistry according to these factors. The likely chemical characteristics of sites could be predicted from map analysis of altitude, solid and drift geology, and oceanicity. There was little evidence of acidification of Shetland streams, but the peatiness of the water made acidification difficult to detect using the usual criteria. Most sites did show a reduction in alkalinity compared to a calculated value for non-acidified sites. (Shidler-PTT)
W88-09629

DISSOLVED ORGANIC CARBON IN STREAMS AND GROUNDWATER,
Waterloo Univ. (Ontario). Dept. of Biology.
J. E. Rutherford, and H. B. N. Hynes.
Hydrobiologia HYDRB8, Vol. 154, p 33-48, November 16, 1987. 10 fig, 8 tab, 34 ref.

Descriptors: *Water chemistry, *Streams, *Groundwater, *Dissolved solids, *Organic matter, Piezometers, Temporal distribution, Spatial distribution, Ontario, Streambeds, Aquatic productivity, Sediments, Stream biota, Mixing.

Minipiezometers installed at different vertical levels (20-140 cm) within the streambed were used to study temporal and spatial variations in the dissolved organic carbon (DOC) content of streamwater and groundwater in three southern Ontario streams (Saugeen River and Canagagigue and Salem Creeks). Groundwater, as represented by our streambed samples, contained considerable quantities of DOC but variation between replicate samples was high. Diel fluctuations in DOC content of streamwater were consistent with daytime autochthonous production and night-time uptake by heterotrophs. Water from the streambed neither consistently diluted nor enhanced streamwater levels of DOC. At some stations, DOC variation with depth, including streamwater, seemed to be largely random. At other stations, DOC concentrations from the deepest piezometers were consistently higher than concentrations at intermediate depths, suggesting a loss of DOC from deeper waters to overlying sediments. However, at these stations DOC concentrations were highest at 20 cm and at the surface. Interflow deliver of DOC to the shallow layers of the streambed may be a significant source of carbon for a stream ecosystem, especially in agricultural areas. Late summer diel fluctuations at one station may be related to changing patterns of intermixing of stream and groundwater in the upper layers of the streambed as governed by velocity heads, convective currents and evapotranspiration. (Author's abstract)
W88-09636

VERTICAL TRANSPORT AND ITS EFFECTS ON EPILIMNETIC PHOSPHORUS IN FOUR CALCAREOUS LAKES,
Wisconsin Univ.-Madison. Water Chemistry Lab.
For primary bibliographic entry see Field 5B.
W88-09639

PHYSICO-CHEMICAL ASPECTS OF PARTITIONING OF NON-POLAR HYDROPHOBIC ORGANICS AT THE AIR-WATER INTERFACE,
Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W88-09653

PRECONCENTRATION AND ANALYSIS OF TETRAPHENYLBORON AND DIPHENYLBORINIC ACID IN NATURAL WATERS USING C18 REVERSE-PHASE LIQUID CHROMATOGRAPHY,
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 5A.
W88-09654

PHOTOLYTIC DEGRADATION OF TRACE AMOUNTS OF DIBROMO-1,2-PROPANE IN WATER: THE INFLUENCE OF HYDROGEN PEROXIDE (DEGRADATION PAR PHOTOLYSE DU DIBROMO-1,2 PROPANE PRESENT A L'ETAT DE TRACES DANS L'EAU: INFLUENCE DU PEROXYDE D'HYDROGENE),
Universite de Toulon et du Var, La Garde (France). Lab. de Chimie Appliquee.
For primary bibliographic entry see Field 5F.
W88-09655

LIMNOLOGY OF A HYPERTROPHIC RESERVOIR STORING WASTEWATER EFFLUENT FOR AGRICULTURE AT KIBBUTZ NA'AN, ISRAEL,
Hebrew Univ., Jerusalem (Israel). Dept. of Zoology.
For primary bibliographic entry see Field 5D.
W88-09695

SALT ACCUMULATION IN THE LOESSIAL SEQUENCE IN THE BE'ER SHEVA BASIN, ISRAEL,
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
For primary bibliographic entry see Field 2B.
W88-09702

TRACE METAL DYNAMICS IN A SEASONALLY ANOXIC LAKE,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 2H.
W88-09708

ROLE OF FISH AND BENTHOS IN THE NITROGEN BUDGET OF LAKE BALATON, HUNGARY,
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 2H.
W88-09752

HYDROGRAPHY OF THE ESTUARINE-LAGUNAR COMPLEX OF CANANEIA (25 DEGREES S; 048 DEGREES W), SAO PAULO, BRAZIL: III. INFLUENCE OF THE TIDE CYCLE (HIDROGRAFIA DO COMPLEXO ESTUARINO LAGUNAR DE CANANEIA (25 DEGREES S; 048 DEGREES W), SAO PAULO, BRASIL: III. INFLUENCIA DO CICLO DA MARE),
Instituto de Pesca, Santos (Brazil). Secao Mariculture.
For primary bibliographic entry see Field 2L.
W88-09773

ECOLOGY OF JACARE PEPIRA RIVER BASIN: MAJOR IONS (SAO PAULO STATE OF BRAZIL) (ECOLOGIA DA BACIA DO RIO JACARE PEPIRA: IONS DOMINANTES, SAO PAULO, BRASIL),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 2H.
W88-09776

ARSENIC IN GROUND WATER OF THE WESTERN UNITED STATES,
Geological Survey, Carson City, NV.
A. H. Welch, M. S. Lico, and J. L. Hughes.
Ground Water GRWAAR, Vol. 26, No. 3, p 333-347, May-June 1988. 7 fig, 5 tab, 110 ref.

Descriptors: *Groundwater quality, *Literature review, *Arsenic, *Aquifers, *Geochemistry, *Sediments, Volcanic deposits, Geothermal systems, Uranium mines, Gold mines, Western United States, Irrigation, Groundwater mining.

Natural occurrences of ground water with moderate (10-50 micrograms/l) to high (>50 micrograms/l) concentrations of arsenic are common throughout much of the western U.S. High concentrations of arsenic are generally associated with one of four geochemical environments: (1) basin-filled deposits of alluvial-lacustrine origin, particularly in semiarid areas, (2) volcanic deposits, (3) geothermal systems, and (4) uranium and gold-mining areas. These findings are based on an extensive literature review, compilation of unpublished reports and data, and the review of data bases containing more than 7000 analyses of ground water samples for arsenic. In the first two environments, arsenic appears to be associated with sediments derived, in part, from volcanic rocks of intermediate to acidic composition. Dissolved arsenic concentrations in water from volcanic aquifers in the same regions, however, may be low (<10 micrograms/l). Solid phases (minerals, amorphous solids, and sedimentary organic matter) that supply the dissolved arsenic have not been identified in most areas. Alluvial and lacustrine sedimentary deposits appear to be an important source of arsenic in volcanic areas and in areas underlain by basin-filled deposits. Mobilization of arsenic in sedimentary aquifers may be, in part, a result of changes in the geochemical environment due to agricultural irrigation. In the deeper subsurface, elevated arsenic concentrations are associated with compaction caused by ground water withdrawals. (Author's abstract)
W88-09787

RECORD OF HEAVY METAL POLLUTION IN SEDIMENT FROM THE SETO INLAND SEA,
Government Industrial Research Inst., Chugoku, Kure (Japan).
For primary bibliographic entry see Field 5B.
W88-09798

CHEMICAL COMPOSITIONS OF SUBMARINE HOT SPRING WATER AND ASSOCIATED BOTTOM SEDIMENTS NEAR TAKETOMI-JIMA AT SOUTHERN PART OF THE RYUKYU ISLAND ARC, NORTH-WEST PACIFIC,
University of the Ryukyus, Nishihara (Japan). Dept. of Chemistry.
T. Oomori.
Journal of Earth Science Nagoya University JEASAD, Vol. 35, No. 2, p 325-340, December 1987. 4 fig, 5 tab, 38 ref.

Descriptors: *Hot springs, *Submarine springs, *Bottom sediments, *Water chemistry, *Geochemistry, Chemical composition, Magnesium, Sulfate, Calcium, Silica, Oxygen isotopes, Heavy metals, Iron, Manganese, Mercury, Arsenic, Antimony, Molybdenum, Cadmium, Barium, Uranium, Protodolomite, Carbonate, Ryukyu Island Arc, Japan.

Chemical compositions of off Taketomi-jima submarine hot spring water and drilled carbonate sediments were studied. Temperature of submarine hot spring water is fairly high (40-60 C). The chemical composition is characterized by decrease in Mg and SO4 concentrations and increase in soluble SiO2 and Ca concentrations, relative to the chemical composition of sea water. The positive value of oxygen isotope (delta-oxygen-18) of hot spring water suggests that rock-water interactions may take place at fairly high temperatures. Heavy metal elements such as Fe, Mn, Hg, As, Sb, Mo, Cd, Ba, and U in drilled carbonate sediments are highly enriched below 6 m in depth of the carbonate sediment, and show the strong positive correlation with protodolomite content of the carbonate sediments. These heavy metal elements and protodolomite may be derived from submarine hydrothermal activity near Taketomi-jima Island. (Author's abstract)
W88-09799

PARTITIONING OF MANGANESE, IRON, ARSENIC, CADMIUM, LEAD, COPPER, ZINC, COBALT AND NICKEL IN SEDIMENTS FROM LAKE BIWA,
Okayama Univ., Kurashiki (Japan). Inst. for Agricultural and Biological Sciences.
For primary bibliographic entry see Field 5B.
W88-09801

DIAGENETIC BEHAVIORS OF HEAVY METALS AND NUTRIENTS IN ANOXIC SEDIMENT OF A FRESHWATER POND,
Central Research Inst. of Electric Power Industry, Tokyo (Japan).
For primary bibliographic entry see Field 2H.
W88-09802

CHEMICAL STUDY OF SURFACE AND GROUND WATERS FLOWING THROUGH CARBONATE ROCK TERRAIN IN THE OKINAWA ISLANDS,
University of the Ryukyus, Nishihara (Japan). Dept. of Chemistry.
For primary bibliographic entry see Field 2F.
W88-09803

GEOCHEMICAL STUDY OF WEATHERING THROUGH CHEMICAL COMPOSITION IN NATURAL WATERS,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
R. Yoshioka.
Journal of Earth Science Nagoya University JEASAD, Vol. 35, No. 2, p 417-444, December 1987. 20 fig, 4 tab, 53 ref.

Descriptors: *Landslides, *Weathering, *Geochemistry, *Water chemistry, *Groundwater, Chemical composition, Carbon dioxide, Minerals, Japan, Thermodynamics, Earthquakes.

The dissolved major constituents of natural waters in landslide areas are discussed, with particular reference to Japanese conditions. The following items are discussed: (1) A fundamental ideas on chemical weathering and landslide phenomena; (2) The possibility of predicting the zones of weakness and landslide caused by chemical weathering; (3) The relation between chemical composition and discharge of groundwater; (4) The partial pressure of CO2 dissolved in groundwater; (5) Analysis of interactions between minerals and water by thermodynamic and mass balance approaches; and (6) landslides caused by earthquakes. (Author's abstract)
W88-09804

AUTOCHTHONOUS CALCITE PRECIPITATION IN HARDWATER LAKES OF THE MECKLENBURG LAKE DISTRICT (AUTOCHTHONE KALKFALLUNG IN HARTWASSERSEEN DER MECKLENBURGER SEENPLATTE),
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 2H.
W88-09809

CONCEPTS OF WELL CLEANING,
Bennett, Williams and Blattert, Inc., Indianapolis, IN.
For primary bibliographic entry see Field 3B.
W88-09832

AMMONIUM AND PHOSPHATE UPTAKE RATES, N:P SUPPLY RATIOS, AND EVIDENCE FOR N AND P LIMITATION IN SOME OLIGOTROPHIC LAKES,
British Columbia Univ., Vancouver. Dept. of Botany.
For primary bibliographic entry see Field 2H.
W88-09845

VARIATIONS IN THE FLUORIDE LEVELS OF DRINKING WATER IN SOUTH AFRICA: IMPLICATIONS FOR FLUORIDE SUPPLEMENTATION,
Stellenbosch Univ. (South Africa). Faculty of Dentistry.
For primary bibliographic entry see Field 5F.
W88-09900

IRON PHOTOREDUCTION AND OXIDATION IN AN ACIDIC MOUNTAIN STREAM,
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-09902

HYDROGEOCHEMISTRY OF CHLORIDE IN AN UPLAND CATCHMENT IN MID-WALES,
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.
For primary bibliographic entry see Field 2A.
W88-09912

CHEMICAL NATURE OF ACID PRECIPITATION OVER EUROPE,
Arizona Univ., Tucson. Inst. of Atmospheric Physics.
For primary bibliographic entry see Field 2B.
W88-09954

TWO-STAGE MINERALIZATION OF PHENANTHRENE BY ESTUARINE ENRICHMENT CULTURES,
New Hampshire Univ., Durham. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W88-09963

ANAEROBIC MICROBIAL DISSOLUTION OF TRANSITION AND HEAVY METAL OXIDES,
Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
For primary bibliographic entry see Field 5B.
W88-09967

INTERACTION OF SELENATE AND SELENITE WITH SELECTED FRESHWATER SEDIMENTS,
Saskatchewan Univ., Saskatoon. Dept. of Soil Science.
For primary bibliographic entry see Field 2H.
W88-09992

GEOCHEMICAL ASSESSMENT OF AQUIFER RECHARGE EFFECTS IN THE SOUTHWEST DENVER BASIN,
Colorado School of Mines, Golden. Dept. of Geology.
For primary bibliographic entry see Field 4B.
W88-10028

DISCHARGE AND WATER QUALITY OF SPRINGS IN ROAN AND PARACHUTE CREEK BASINS, NORTHWESTERN COLORADO, 1981-83,
Geological Survey, Grand Junction, CO. Water Resources Div.
D. L. Butler.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources Investigations Report 85-4078, 1985. 145 p, 17 fig, 16 tab, plate, 56 ref.

Descriptors: *Springs, *Oil shale, *Water quality, *Discharge, *Water chemistry, Base-line studies, Perched groundwater, Tritium, Groundwater movement.

This report is a compilation and interpretation of discharge, water-quality, and radiochemical data collected at springs in the oil-shale regions of Roan and Parachute Creek basins, Colorado, from 1981 to 1983. Springs located on upland plateaus and ridges are mixed-cation bicarbonate water types with 216 to 713 milligrams per liter dissolved solids. Calcite and dolomite dissolution are dominant chemical reactions in upland springs. Springs located in the canyons contain greater concentrations of sodium and sulfate and have 388 to 3,970 milligrams per liter dissolved solids. Gypsum dissolution is an important chemical reaction in canyon spring water. The only trace constituents with mean concentration greater than 10 micrograms per liter in the study area were barium, boron, lithium and strontium. None of the canyon springs investigated represent discharge from the lower aquifer in the Green River Formation. Analysis of chemical and discharge data for streams in the Roan Creek drainage showed evidence of lower-aquifer discharge into the canyons. Springs located near an oil-shale mine or processing plant could be used for monitoring groundwater quality and quantity. Bicarbonate, fluoride, arsenic, boron, lithium, mercury, ammonia, and organic carbon may be chemical indicators of mine or process-water contamination of shallow aquifers near an oil-shale plant or mine. (USGS)
W88-10062

2L. Estuaries

AIR-SEA TRANSFER OF TRACE ELEMENTS,
Rhode Island Univ., Kingston. Graduate School of Oceanography.
For primary bibliographic entry see Field 5B.
W88-09070

MECHANISMS CONTROLLING THE DISTRIBUTION OF TRACE ELEMENTS IN OCEANS AND LAKES,
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 2H.
W88-09071

SALT MARSH RESTORATION: LESSONS FROM CALIFORNIA,
San Diego State Univ., CA. Dept. of Biology.
J. B. Zedler.
IN: Rehabilitating Damaged Ecosystems. Volume I. CRC Press Inc., Boca Raton, Florida. 1988. p 123-138, 1 tab, 64 ref, 2 append.

Descriptors: *Salt marshes, *Wetlands, *Rehabilitation, *Regional planning, *Restoration, *California, Management planning, Wildlife management, Vegetation, Aquatic plants.

A broad range of guidelines for restoring salt marshes have developed from long-term research on wetlands, from observing restoration failures, and from literature review. The restoration literature includes many wetland projects from the eastern U.S., while many California salt marsh examples are evaluated here for the first time. Recommendations for goal definition are: (1) regional coordination, rather than piecemeal planning, is needed to maintain the salt marsh resources of the region; (2) off-site mitigation should be discouraged; (3) species requirements must be well understood; (4) habitat for endangered species must be considered in developing regional restoration plans and site-specific objections; (5) other species that are rare or uncommon should also be considered in setting restoration goals for souther California; (6) maintaining native plant communities that are uncommon within a region is also an appropriate restoration objective; (7) reserves of rare plant species may need to be developed for artificial propagation and reintroduction to individual salt marshes following local extinction; and (8) increasing 'diversity' is not necessarily beneficial; maintenance of the 'natural variety' of communities is a more appropriate regional goal. Hydrological planning, experimentation, and assessment of success, with respect to salt marsh restoration, are also discussed. (See also W88-09438) (Lantz-PTT)
W88-09455

METHODS OF RECOVERING VIRUSES FROM AQUATIC SEDIMENTS,
Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
For primary bibliographic entry see Field 5A.
W88-09465

ROLE OF SEDIMENT IN THE PERSISTENCE AND TRANSPORT OF ENTERIC VIRUSES IN THE ESTUARINE ENVIRONMENT,
University of Southern Mississippi, Hattiesburg. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W88-09466

CHARACTERIZATION OF SEDIMENTARY HUMIC ACIDS FRACTIONATED BY HYDROPHOBIC INTERACTION CHROMATOGRAPHY,
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. de Biologie Appliquee.
E. Kalinowski, and R. Blondeau.
Marine Chemistry MRCHBD, Vol. 24, No. 1, p 29-37, 1988. 3 fig, 2 tab, 29 ref.

Descriptors: *Chemical analysis, *Sediments, *Monosaccharides, *Spectroscopy, *Humic acids, *Chromatography, *Estuaries, Fulvic acids, Nuclear magnetic resonance, Infrared radiation, Molecular structure.

Sedimentary humic acid subfractions, obtained by hydrophobic interaction chromatography on Octyl-Sepharose CL-4B, have been studied by molecular weight distribution, IR and 13C NMR spectroscopies and chemical analysis. Remarkably, the more hydrophilic subfraction exhibits high carboxyl group content, low aromaticity and high carbohydrate content. The composition of the different monosaccharides of this subfraction (fucose, galactose, mannose, glucose, rhamnose, arabinose and xylose) is not different from whole humic acid. The chemical and spectroscopic characteristics resemble those of fulvic acid, with the exception of acid insolubility and molecular weight. An increase of dominant average molecular weight is noted in relation to the hydrophobic character of subfractions. (Author's abstract)
W88-09560

FACIES AND GEOMETRY OF AN ESTUARINE BAR AND CHANNEL SYSTEM,
Bordeaux-3 Univ., Talence (France). Inst. de Geodynamique.
P. Crumeyrolle, and M. Marianne.
Comptes Rendus de l'Academie des Sciences (Series 2) CHDCAQ, Vol. 306, No. 14, p 997-1000, April 14, 1988. 4 fig, 7 ref.

Descriptors: *Bottom sediements, *Sediments, *Deltas, *Estuaries, *Sedimentary structures, *Stratigraphy, France, Persian Gulf, Eocene, Facies, Channels.

A spectacular example of estuarine bar and channel deposits has been studied in the Eocene of South France (Corbieres region). The outcrops are sufficiently extensive so as to permit the observation and analysis of sedimentary geometry and facies. The deposits are interpreted as a system of tidal estuarine inlet bars, incised by a contemporaneous flood tide dominated channel. The bar is typically upward coarsening and exhibits stacked beds of undirectional ebb oriented sigmoidal cross beds. These cross beds are bundled into neap spring cycles and contain numerous reactivation surfaces, clay drapes and scattered subordinate current ripple caps. The overall planar geometry of the bar system is roughly elliptical, 800 m wide and 1 to 2 km long (parallel to currents) and 20 to 30 m thick. To the east, i.e., parallel to the coast (and perpendicular to north dominant tidal currents), facies become wave dominated with wave ripples predominantly. This transition between tidal and shoreface sands is transitional and interfingering. The phenonena evident here are observed frequently as at Mont Saint-Michel and the Persian Gulf. (Author's abstract)
W88-09562

USE OF POLLUTANT AND BIOGENIC MARKERS AS SOURCE DISCRIMINANTS OF ORGANIC INPUTS TO ESTUARINE SEDIMENTS,
Institute for Marine Environmental Research, Plymouth (England).
For primary bibliographic entry see Field 5B.
W88-09566

ORIGIN OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH) IN RECENT SEDIMENTS FROM THE CONTINENTAL SHELF OF THE 'GOLFE DE GASCOGNE' (ATLANTIC OCEAN) AND IN THE GIRONDE ESTUARY,
Bordeaux-1 Univ., Talence (France). Groupe d'Oceanographie Physicochimique.
For primary bibliographic entry see Field 5B.
W88-09576

EVOLUTION OF HYDROCARBONS AND BACTERIAL ACTIVITY IN MARINE SEDIMENTS CONTAMINATED BY A MIXTURE OF PETROLEUM PRODUCT AND ENHANCER (EVOLUTION DES HYDROCARBURES ET DE L'ACTIVITE BACTERIENNE DANS DES SEDIMENTS MARINS CONTAMINES PAR UN DEVERSEMENT DE PETROLE BRUT ET TRAITE),
Institut Francais de Recherche pour l'Exploitation de la Mer, Brest.
For primary bibliographic entry see Field 5B.
W88-09587

CHARACTERISTIC LEVELS OF CHLORINATED HYDROCARBONS AND TRACE METALS IN FISH FROM COASTAL WATERS OF NORTH AND BALTIC SEA,
Stadtisches Unterscuhingsamt Flensburg (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W88-09588

EXAMINATION OF THE FATE OF NIGERIAN CRUDE OIL IN SURFACE SEDIMENTS OF THE HUMBER ESTUARY BY GAS CHROMATOGRAPHY-MASS SPECTROMETRY,
Newcastle upon Tyne Univ. (England). Organic Geochemistry Unit.
For primary bibliographic entry see Field 5B.
W88-09601

POLYCYCLIC AROMATIC HYDROCARBONS, IN SURFACE SEDIMENTS FROM THE ELIZABETH RIVER SUBESTUARY,
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5B.
W88-09616

POPULATION DYNAMICS AND SECONDARY PRODUCTION IN AN ESTUARINE POPULATION OF CAULLERIELLA CAPUTESOCIS (POLYCHAETA: CIRRATULIDAE),
Lagos Univ. (Nigeria). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W88-09666

ENVIRONMENTAL FACTORS INFLUENCING THE OCCURRENCE OF JUVENILE FISH IN THE MANGROVES OF PAGBILAO, PHILIPPINES,
Open Univ. of Sri Lanka, Nawala. Dept. of Zoology.
L. Pinto.
Hydrobiologia HYDRB8, Vol.150, No. 3, p 283-301, July 30, 1987. 9 fig, 4 tab, 35 ref.

Descriptors: *Aquatic environment, *Juvenile growth stage, *Fish, *Species diversity, *Species composition, *Mangrove swamps, Nitrates, Organic carbon, Litter, Silicates, Hydrogen ion concentration, Salinity, Carotenoids, Phosphates, Glass-

fish, Agricultural runoff, Fish ponds, Rice, Philippines.

The study was conducted in the mangrove reserve of Pagbilao, Philippines; two rivers traverse the mangrove forest before entering a bay. 128 fish species belonging to 54 families were collected from the mangroves of Pagbilao. Ambassis kopsi (Ambassidae) was the most abundant species. Fourteen environmental factors were correlated to the catch per unit time for some species. The occurrence of A. kopsi was positively correlated to nitrate in the water, carbon in the sediments and litter fall. Since the two rivers in the study cross rice fields and pass fish ponds and residential huts, it is possible that some N-N03 had come from fertilizers and domestic wastes in addition to from litter decomposition. Out of the 8 species investigated, 6 were positively correlated to litter fall. Three species showed positive correlation to phosphate in the water, two to organic carbon in the sediments, nitrate, silicate and pH, and one to salinity and carotenoids in the water. The biomass of the total catch was correlated to carbon in the sediments and litter fall. (Author's abstract)
W88-09696

SEDIMENTARY SULFIDE IN THE NEAR-SHORE GEORGIA BIGHT,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE. Haskell Lab. for Toxicology and Industrial Medicine.
R. D. Fallon.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 25, No. 6, p 607-619, December 1987. 6 fig, 4 tab, 46 ref.

Descriptors: *Sulfides, *Marine sediments, *Neritic environments, Sediments, Georgia Bight, Sulfur compounds, Iron, Organic matter, Coastal waters, Bights, Tidal effects, Water currents, Hydrogen sulfide, Iron sulfide.

Sedimentary sulfide, iron, and organic matter were measured in neritic sediments from the Georgia Bight. The two measured depth integrated sulfur pools, FeS + HS(-) and FeS2, tended to decrease with increasing distance from shore out to 33 km. Total iron and organic matter were strongly correlated and both tended to decrease with increasing distance from shore. Sediment depth profiles of organic matter/reduced sulfur suggest relatively constant rates of sulfate reduction over the top 40 cm of sediment. Differences in within-station variance indicated regions of lower and higher spatial/temporal heterogeneity, that may be related to tidally driven circulation patterns. No seasonal cycles were evident in sedimentary sulfides. (Author's abstract)
W88-09711

SHEAR STRESS VARIATIONS IN AN ESTUARY,
Imperial Chemical Industries Ltd., Brixham (England). Brixham Lab.
R. E. Lewis, and J. O. Lewis.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 25, No. 6, p 621-635, December 1987. 8 fig, 2 tab, 28 ref.

Descriptors: *Shear stress, *Estuaries, *Tidal hydraulics, *Mathematical studies, *Tidal effects, Tees Estuary, England, Coastal waters, Density, Velocity, Drag, Boundary layer theory, Drag coefficient, Mathematical equations, Stress.

Observations in 1929 of the tidal variation of surface gradients in the Tees estuary were combined with measurements of the velocity and density structure in 1975 to compute the internal and boundary shear stresses. Drag coefficients were generally higher on ebb than on flood tides and this inequality is explained using established boundary layer theory. The results suggest that the wide variations in drag coefficients in estuaries may depend, in addition to roughness changes, on the bed slope and the available kinetic energy of the mean flow. (Author's abstract)
W88-09712

COPEPOD COLONIZATION OF NATURAL AND ARTIFICIAL SUBSTRATES IN A SALT MARSH POOL,
Northeastern Univ., Boston, MA. Dept. of Biology.
E. Cummings, and E. Ruber.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 25, No. 6, p 637-645, December 1987. 4 fig, 1 tab, 15 ref.

Descriptors: *Artificial substrates, *Colonization, *Copepods, *Crustaceans, *Salt marshes, *Population density, Marshes, Aquatic animals, Populations, Aquatic populations, Massachusetts, Spartina, Plastics, Nitrogen, Decomposing organic matter, Detritus, Litter.

Pre-weighed packets of Spartina alterniflora and of plastic (polypropylene) twine were placed in a salt marsh pool on a wildlife refuge in Massachusetts and recovered on 40 dates spanning 14 months. New packets were placed out regularly to provide contrast with ageing material. Twelve species of copepods were extracted, counted, and identified. Dry weight and Kjeldahl-nitrogen were determined for Spartina packets. Eight species of copepods, Amphiascus pallidus, Onychocamptus mohammed, Cletocamptus deitersei, Halicyclops sp., Harpacticus chelifer, Mesochra lilljeborgii, Metis jousseaumei and Nitocra sp. were found in higher densities on old grass or plastic packets than on new. The quantity of material was important in that the relative attractiveness of old grass was much lower early in the second year when 7-15% dry weight (dw) and 0.7% nitrogen remained than early in the first year when over 60% dw and 2.0% nitrogen remained. Old polypropylene was equally or more attractive than old grass to 7 of 8 species, therefore nitrogen decline in old grass was not the factor making it less attractive. Once aged, the quantity of substrate was more important than its quality. Apparently, this is due to colonization by microflora or settlement of detritus but these were not studied. The four clear exceptions to these trends were Darcythompsonia fairliensis and Eurytemora affinis which showed highest densities 72% and 50% of the time in new grass, Apocyclops spartinus with 70% in grass and equal numbers between old and new packets and Acartia tonsa a bay calanoid with 82% of highest densities in the water column and only two occurrences out of 40 dates in the packets. (Author's abstract)
W88-09713

ECOLOGY OF LOUGH INE: PART 24. THE FLORA AND FAUNA ASSOCIATED WITH HIMANTHALIA ELONGATA (L.) S.F. GRAY IN RELATION TO WATER CURRENT AND WAVE ACTION IN THE LOUGH HYNE MARINE NATURE RESERVE,
University of East Anglia, Norwich (England). School of Biological Sciences.
J. A. Kitching.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 25, No. 6, p 663-676, December 1987. 4 fig, 3 tab, 28 ref.

Descriptors: *Colonization, *Algae, *Epiphytes, *Water currents, *Wave action, *Rivers, Streams, Littoral zone, Littoral environment, Aquatic animals, Aquatic plants, Ireland, Artificial substrates, Bryozoa, Amphipods, Gastropods, Spirorbid worms.

The growth of epiphytes (plant and animal) was investigated at various stages in the development of the low littoral alga Himanthalia elongata in the Lough Hyne Marine Nature Reserve, Ireland. The vegetative thallus, or button, is very resistant to the settlement of epiphytes on its upper surface, but susceptible to extensive coverage on its lower surface and stalk, especially by Bryozoa and spirorbid worms. The receptacles or straps are invaded by a microforest of filamentous algae, which in turn provides accommodation and in many cases food for many invertebrates, including gastropods, amphipods and larval Diptera. Spirorbid worms on the underbuttons are confined to sites sheltered form strong water currents and wave action, but other epiphytes of the underbuttons show little regard for these features. Microforest and its associated fauna are restricted to sheltered sites. Perspex discs set up as imitation Himanthalia buttons were colonized by the same epiphytes as real Himanthalia buttons, but on both sides, indicating the existence of a special protective mechanism for the upper surfaces of real Himanthalia buttons. (Author's abstract)
W88-09714

GEOMORPHOLOGICAL CONTROL OF SUBSURFACE HYDROLOGY IN THE CREEK-BANK ZONE OF TIDAL MARSHES,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
J. W. Harvey, P. F. Germann, and W. E. Odum.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 25, No. 6, p 677-691, December 1987. 7 fig, 30 ref.

Descriptors: *Estuarine environment, *Hydrology, *Geomorphology, *Tidal marshes, *Groundwater movement, *Model studies, Interstitial water, Subsurface water, Salt marshes, Marshes, Spartina, Soil properties, Wetlands, Chesapeake Bay, Carter Creek, Mathematical models, Mathematical equations, Hydrologic models, Hydrologic properties, Sensitivity analysis, Topography.

A combination of field and numerical modeling methods were used to assess pore-water movement in a narrow (20 m) Spartina marsh which is located at Carter Creek in a sub-estuary of the Chesapeake Bay and which is flooded regularly by tidal waters. Soil composition and soil hydraulic properties did not vary across the marsh or with depth. Hydraulic head was monitored on a transect perpendicular to the creekbank. During exposure of the marsh surface, hydraulic gradients were predominantly horizontal; vertical gradients were small or zero. Subsurface flow was directed from the marsh interior toward the creekbank. Approximately 14 liters of pore water were discharged laterally to the adjacent tidal creek per meter of creekbank over a complete tidal cycle. A numerical hydrological model was modified to simulate subsurface hydraulics in the creekbank vicinity of regularly flooded tidal marshes. The model was parameterized to represent soil conditions, tidal fluctuations and topography at the field site. Observed changes in hydraulic head over complete tidal cycles were accurately predicted by the model. Model simulations identified the vertical infiltration of creek water into the marsh surface at the onset of tidal flooding as the primary source (66%) for the replacement of water drained at the creekbank. Significant replacement (31%) also occurred as discharge from the interior marsh. Horizontal recharge at the creekbank was minimal (3%). A sensitivity analysis was conducted with the model to assess the relative importance of geomorphological factors and soil properties in controlling pore water export at the creekbank of tidal marsh soils. Each parameter was varied systematically over a realistic range for field conditions. Changes in marsh elevation exerted greater control over creekbank discharge than changes in soil hydraulic properties. More rapid turnover of pore water near creekbanks of higher elevation marshes is hypothesized. (Author's abstract)
W88-09715

EFFECT OF BIOLOGICAL AND PHYSICAL DISTURBANCES ON THE TRANSPORT OF ARSENIC FROM CONTAMINATED ESTUARINE SEDIMENTS,
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 5B.
W88-09716

VERTICAL ATTENUATION OF LIGHT IN CHARLOTTE HARBOR, A SHALLOW, SUBTROPICAL ESTUARY, SOUTH-WESTERN FLORIDA,
Geological Survey, Tampa, FL.
B. F. McPherson, and R. L. Miller.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 25, No. 6, p 721-737, December 1987. 12 fig, 2 tab, 41 ref.

Descriptors: *Light penetration, *Estuaries, *Light attenuation, Radiation, Particulate matter, Suspended solids, Organic matter, Charlotte Harbor, Florida, Attenuation coefficient, Aquatic plants, Chlorophyll, Dissolved solids.

The relative contribution of different components to the attenuation of photosynthetically active radiation was determined in the Charlotte Harbor estuarine system based on laboratory and in situ measurements. Agreement between laboratory and in situ measurements of the attenuation coefficient was good (r square = 0.92). For all in situ measurements (n = 100), suspended, non-chlorophyll matter accounted for an average of 72% of the attenuation coefficient, dissolved matter accounted for 21%, suspended chlorophyll for 4%, and water for the remaining 3%. For individual determinations, suspended non-chlorophyll matter, dissolved matter, suspended chlorophyll, and water, each accounted for as much as 99%, 79%, 21%, and 18% of the attenuation coefficient. Attenuation by suspended matter was greatest near the mouth of the northern tidal rivers and was variable over the rest of the estuarine system. Attenuation by dissolved matter was greatest in the brackish tidal rivers and decreased with increasing salinity. Attenuation due to dissolved matter was positively correlated with water color. The source of the color was basin runoff. Wavelength transmittance changed along the salinity gradient. Maximum transmittance shifted from 500 to 600 nm in gulf waters to 650 to 700 nm in colored, brackish waters. Dissolved matter was primarily responsible for the large attenuation at short wavelengths (400-500 nm). (Author's abstract)
W88-09717

BENTHIC ECOLOGY OF LOCH LINNHE AND LOCH EIL, A SEA-LOCH SYSTEM ON THE WEST COAST OF SCOTLAND. V. BIOLOGY OF THE DOMINANT SOFT-BOTTOM EPIFAUNA AND THEIR INTERACTION WITH THE INFAUNA,
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5C.
W88-09730

NEPHROPS NORVEGICUS: FIELD STUDY OF EFFECTS OF OXYGEN DEFICIENCY ON HAEMOCYANIN CONCENTRATION,
Copenhagen Univ. (Denmark). Marine Biological Lab.
L. Hagerman, and S. Pihl Baden.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 116, No. 2, p 135-142, April 1988. 2 fig, 1 tab, 19 ref.

Descriptors: *Crustacean physiology, *Crustaceans, *Oxygen deficiency effects, *Hemocyanin, *Seawater, Oxygen deficit, Oxygen, Kattegat, Feeding rates, Bottom water.

A 2-month period of oxygen deficiency occurred in parts of the southern Kattegat during the late summer of 1986, and was accompanied by commercial catches of Nephrops which included dead, moribund, and pale-colored animals. Hemocyanin levels in live animals at this time were very low when compared with a representative population sampled off eastern Scotland. It is contended that the hypoxia affected the feeding activity of Nephrops and that the resulting starvation induced the low haemocyanin values. Such events have been observed elsewhere in laboratory studies. In some of the sampling areas, population hemocyanin levels recovered following the return to normoxic conditions after the autumnal storms. (Author's abstract)
W88-09731

PREDATION AS A MECHANISM OF INTERFERENCE WITHIN INFAUNA IN SHALLOW BRACKISH WATER SOFT BOTTOMS; EXPERIMENTS WITH AN INFAUNA PREDATOR, NEREIS DIVERSICOLOR O.F. MULLER,
Abo Akademi, Turku (Finland). Dept. of Biology.
C. Ronn, E. Bonsdorff, and W. G. Nelson.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 116, No. 2, p 143-157, April 1988. 6 fig, 2 tab, 44 ref.

Descriptors: *Polychaetes, *Aquatic animals, *Predation, *Population density, Populations, Aquatic populations, Bottom water, Baltic Sea, Brackish water, Seawater, Nereis diversicolor.

Field and laboratory experiments were used to determine the importance of the polychaete Nereis diversicolor O.F. Muller in structuring a soft-bottom community in the northern Baltic Sea proper. In the field, areas of the natural bottom were enclosed with cylinders, which also enclosed artificially elevated polychaete densities. During the experimental period, Nereis reduced the abundance of the most dominant species, Chironomidae larvae, and thus caused the diversity to increase. In the laboratory, the effects of Nereis as a predator vs. disturber were tested. Nereis was shown to be a potential predator on all of the prey species tested: Chironomidae larvae, Corophium volutator (Pallas), and small Macoma balthica (L.). Higher numbers of Nereis and a mechanical disturbance source caused increased emigration of Corophium; lower densities of the polychaete had little or no impact on the emigration of the prey organism. Nereis is suggested to be an important structuring factor (through active predation and disturbance) in this ecosystem. (Author's abstract)
W88-09732

COASTAL MANAGEMENT ISSUES FOR THE MOUTH OF THE RIVER MURRAY, SOUTH AUSTRALIA,
South Australia Dept. of Environment and Planning, Adelaide.
N. Harvey.
Coastal Management CZMJBF, Vol. 16, p 139-149, 1988. 1 fig, 28 ref.

Descriptors: *Coastal zone management, *Sedimentation, *Estuarine environment, *Management planning, *Governmental interrelations, *Interagency cooperation, Saline-freshwater interfaces, Coastal streams, Australia, River Murray, Marine sediments, Estuaries, Rivers, Obstruction to flow.

The management issues relating to the potential closure of the mouth of Australia's largest river due to marine sediment are examined. It is important to maintain the river flow to avoid rising salinity levels in adjoining Coorong Lagoon that would cause ecological changes that could damage existing fishing and touriam industries. Potential flooding is also a concern. The mouth was artificially opened in 1981 following its closure and at that time monitoring was begun. Possible management options include: (1) clearing the mouth with fresh water stored in adjacent lakes, (2) dredging, (3) provision of temporary groins, and (4) installation of drift fencing. One of the major unresolved issues is the question of responsibility and funding, which has arisen because of overlapping jurisdictions on either side of the river mouth and a lack of jurisdiction for the mouth itself, which is an administrative boundary. (White-Reimer-PTT)
W88-09763

INFLUENCE OF WASTEWATER DISCHARGE ON THE UPTAKE KINETICS OF DISSOLVED ORGANIC MATERIALS BY MICROORGANISMS IN THE FRASER RIVER ESTUARY, BRITISH COLUMBIA,
Tsukuba Univ. (Japan). Inst. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W88-09767

HYDROGRAPHY OF THE ESTUARINE-LAGUNAR COMPLEX OF CANANEIA (25 DEGREES S; 048 DEGREES W), SAO PAULO, BRAZIL: III. INFLUENCE OF THE TIDE CYCLE (HIDROGRAFIA DO COMPLEXO ESTUARINO LAGUNAR DE CANANEIA (25 DEGREES S; 048 DEGREES W), SAO PAULO, BRASIL: III. INFLUENCIA DO CICLO DA MARE),
Instituto de Pesca, Santos (Brazil). Secao Mariscultura.
M. Mishima, N. Yamanaka, O. Jacobsen, O. M. Pereira, and F. Chagas-Soares.
Boletim do Instituto de Pesca, Vol. 13, No. 1, p 51-70, June 1986. 29 fig, 1 tab, 11 ref.

Descriptors: *Cananeia Estuary, *Tidal effects, *Dam effects, *Hydrography, *Estuaries, *Tides, *Dams, *Chemical properties, Optical properties, Transparency, Dissolved oxygen, Salinity, Temperature, Diurnal distribution, Vertical disribution, Temporal distribution, Brazil.

Diurnal variation and vertical distribution of salinity, temperature, transparency and dissolved oxygen of Cananeia Estuary are presented. The data were collected at 8 stations from 1973 to 1980 throughout a period which varied from 4 to 26 hours, and at intervals of approximately one hour. It was observed that the longitudinal, vertical and temporal distributions of those parameters are affected by the tide cycle both before and after the dam-building across Valo Grande. The range of variation in salinity decreased after the building of the dam, consequently the renewal rate of the waters in the estuary probably has changed. (Author's abstract)
W88-09773

LABORATORY STUDIES ON CORE SAMPLING WITH APPLICATION TO SUBTIDAL MEIOBENTHOS COLLECTION,
Louisiana State Univ., Baton Rouge. Dept. of Zoology and Physiology.
For primary bibliographic entry see Field 7B.
W88-09847

UNDERICE GRAZING BY PLANKTONIC, CALANOID COPEPODS IN RELATION TO A BLOOM OF ICE MICROALGAE IN SOUTHEASTERN HUDSON BAY,
McGill Univ., Montreal (Quebec). Inst. of Oceanography.
J. A. Runge, and R. G. Ingram.
Limnology and Oceanography LIOCAH, Vol. 33, No. 2, p 280-286, March 1988. 6 fig, 19 ref.

Descriptors: *Coastal waters, *Plankton, *Zooplankton, *Algae, *Ice-water interfaces, *Arctic, Copepods, Calanus, Ice, Sea ice, Eutrophication, Hudson Bay, Pigments, Diatoms, Flagellates, Phytoplankton.

A spring bloom of ice microalgae was observed at a station on southeastern Hudson Bay. Levels of pheopigments in guts of females of Calanus glacialis and Pseudocalanus spp., the dominant calanoid copepods in this region, increased by an order of magnitude after onset of the bloom. Feeding had a diel cycle and was associated with a nighttime migration of females to the ice-water interface. Fragments of pennate, ice diatoms were observed microscopically in most guts of Calanus and Metridia, but only rarely in Pseudocalanus, which may have been feeding on flagellates associated with the ice-water interface. The results suggest that ice microalgae in Hudson Bay are a regular and significant source of nutrition for planktonic copepods before the phytoplankton bloom. The structure of the layer at the ice-water interface may influence feeding behavior on ice microalgae by arctic copepods. (Author's abstract)
W88-09848

MOTILE EPIFAUNA OF MARINE MACROPHYTES IN THE INDIAN RIVER LAGOON, FLORIDA: I. COMPARISONS AMONG THREE SPECIES OF SEAGRASSES FROM ADJACENT BEDS,
Harbor Branch Foundation, Inc., Fort Pierce, FL.
R. W. Virnstein, and R. K. Howard.
Bulletin of Marine Science, Vol. 41, No. 1, p 1-12, July 1987. 2 fig, 3 tab, 28 ref.

Descriptors: *Invertebrates, *Estuaries, *Sea grasses, *Macrophytes, *Aquatic plants, *Population dynamics, *Aquatic habitats, Species composition, Biomass, Comparison studies, Sampling, Florida, Gastropods, Crustaceans, Prediction, Indian River Lagoon.

A newly-designed sampler was used to quantitatively sample the epifauna associated with three morphologically distinct seagrasses occurring in adjacent beds within 60 m of each other. Thalassia testudinum, Halodule wrightii, and Syringodium filiforme. Similar suites of epifaunal species occurred on all three seagrass species, with a mean of 82% of the species in common; relative abundance, however, differed greatly. All of the top 11 species had significant differences in abundance when standardized to (1) bottom surface area, (2) plant biomass, of (3) plant surface area. Total epifaunal density and gastropod density (per sq m of bottom) were greatest on Halodule, while crustacean density was greatest on Thalassia. However, per plant biomass and especially per plant surface area, crustaceans were by far most abundant on Syringodium, despite Syringodium's low biomass and low surface area-to-biomass ratio. Although considered true in previous studies, neither plant biomass nor plant surface area was a good predictor of patterns of epifaunal abundance. Differential survivorship and active habitat selectivity, in combination with seagrass species composition, are probably also important. (See also W88-09858) (Author's abstract)
W88-09857

MOTILE EPIFAUNA OF MARINE MACROPHYTES IN THE INDIAN RIVER LAGOON, FLORIDA: II. COMPARISONS BETWEEN DRIFT ALGAE AND THREE SPECIES OF SEAGRASSES,
Harbor Branch Foundation, Inc., Fort Pierce, FL.
R. W. Virnstein, and R. K. Howard.
Bulletin of Marine Science, Vol. 41, No. 1, p 13-26, July 1987. 5 fig, 3 tab, 46 ref.

Descriptors: *Estuaries, *Sea grasses, *Invertebrates, *Macrophytes, *Aquatic plants, *Population dynamics, *Aquatic habitats, Indian River Lagoon, Biomass, Algae, Florida, Predication, Gastropods, Crustaceans.

Within each of three adjacent monospecific beds of seagrasses in the Indian River Lagoon, Florida, the motile epifauna of seagrass and drift algae were quantitatively sampled. In spite of sometimes large and significant differences in abundance of many epifaunal species, the lists of species on all substrata were similar, with an average of 75% of 47 species in common, mostly gastropods and peracarid crustaceans. Similarity analysis grouped faunas by substratum type (i.e., either algae or seagrass) rather than by site. At each site, the majority of the top 15 species had significant differences in abundance between seagrass and algae, both in terms of individuals per unit plant biomass and per unit plant surface area. Gastropod species were usually significantly more abundant on seagrass than on algae, whereas crustaceans were more abundant on algae. Both plant biomass and plant surface area were poor predictors of epifaunal abundances across substratum types, contrary to earlier predictions. These strong plant-animal associations may be due to differential survivorship and/or active habitat selection. The former may be particularly important in determining relative abundance of gastropods and crustaceans. When locally abundant, drift algae can be an important component of seagrass systems, and may provide superior refuge, food and habitat over seagrasses for associated epifauna. (See also W88-09857) (Author's abstract)
W88-09858

HYDROGRAPHY AND BUDGET OF DISSOLVED TOTAL NITROGEN AND DISSOLVED OXYGEN IN THE STRATIFIED SEASON IN MIKAWA BAY, JAPAN,
Aichi Prefectural Fisheries Experimental Station, Gamagori (Japan).
For primary bibliographic entry see Field 5C.
W88-09863

BOX MODEL ANALYSIS ON PHYTOPLANKTON PRODUCTION AND GRAZING PRESSURE IN A EUTROPHIC ESTUARY,
Aichi Prefectural Marine Culture Center, Atsumi (Japan).
T. Suzuki, K. Ishii, K. Imao, and Y. Matsukawa.
Journal of the Oceanographical Society of Japan NKGKB4, Vol. 43, No. 5, p 261-275, October 1987. 9 fig, 5 tab, 37 ref.

Descriptors: *Estuaries, *Hydrography, *Nitrogen, *Coastal waters, *Food chains, *Primary productivity, *Biomass, *Phytoplankton, *Zooplankton, Dissolved oxygen, Cycling nutrients, Model studies, Mathematical studies, Arsumi Bay, Water currents, Population dynamics, Japan, Estuaries, Protozoa.

To determine the quantitative relationship between phytoplankton production and zooplankton grazing pressure in Atsumi Bay, a eutrophic and partially-mixed estuary, a series of investigations, including measurements of hydrographic conditions, dissolved oxygen, dissolved total nitrogen, particulate organic nitrogen, and phyto- and zooplankton biomass were conducted 13 times at intervals of 2-7 days in June and July 1984. Continuous measurements of water flow and salinity were also carried out to examine transverse flow and horizontal diffusivity. The supply of freshwater and nitrogen was estimated from given data. The changes of hydrographic condition, net photosynthetic rate and community primary production was compared to the one estimated from zooplankton biomass and sardine, Sardinops melonosticta, biomass. The agreement between the data was remarkable in the upper layer, showing the grazing pressure on phytoplankton followed phytoplankton production, suggesting that a large part of produced phytoplankton was immediately grazed by zooplankton. Consequently, the community primary production was depressed to a fairly lower level. An important role of nutrient supply and water circulation, to limit phytoplankton production, was also confirmed. Dynamic response observed between the calculated grazing pressure and the biomass of phytoplankton and protozoa was also analyzed. (Author's abstract)
W88-09864

TIDAL INFLUENCE ON THE WETLAND COMMUNITY STRUCTURE BEHIND THE DIKE ALONG THE ELBE ESTUARY,
Hamburg Univ. (Germany, F.R.). Inst. fuer Hydrobiologie und Fischereiwissenschaft.
For primary bibliographic entry see Field 2H.
W88-09875

EFFECT OF TIDAL ACTION ON THE DISTRIBUTION OF NUTRIENTS AND HEAVY METALS IN FLAT SEDIMENTS OF THE ELBE ESTUARY, (DER EINFLUSS DER GEZEITEN AUF DIE VERTEILING VON NAHRSTOFFEN UND SCHWERMETALLEN IN WATTSEDIMENTEN DES ELBE-AESTUARS),
Hamburg Univ. (Germany, F.R.). Inst. fuer Hydrobiologie und Fischereiwissenschaft.
For primary bibliographic entry see Field 5B.
W88-09876

AQUATIC MACROPHYTES OUTSIDE THE OLKILUOTO NUCLEAR POWER STATION, WEST COAST OF FINLAND,
Finnish Centre for Radiation and Nuclear Safety, Helsinki.
For primary bibliographic entry see Field 5C.
W88-09938

CARBON FIXATION OF PHYTOPLANKTON SPECIES IN COOLING WATER OF THE OLKILUOTO NUCLEAR POWER STATION, WEST COAST OF FINLAND,
Finnish Centre for Radiation and Nuclear Safety, Helsinki.
For primary bibliographic entry see Field 5C.
W88-09939

PHYTOPLANKTON IN THE SEA AREA AROUND THE LOVIISA NUCLEAR POWER STATION, SOUTH COAST OF FINLAND,
Finnish Centre for Radiation and Nuclear Safety, Helsinki.
For primary bibliographic entry see Field 5C.
W88-09940

PHYTOPLANKTON IN THE SEA AREA OFF THE OLKILUOTO NUCLEAR POWER STATION, WEST COAST OF FINLAND,
Finnish Centre for Radiation and Nuclear Safety, Helsinki.
For primary bibliographic entry see Field 5C.
W88-09942

RED TIDE IN SOUTHERN NORWAY CAUSED BY MASS OCCURRENCE OF THE PLANKTONIC CILIATE TIARINA FUSUS (RODT VANN VED TVEDESTRAND-MASSEFOREKOMST AV FLIMMERDYRET TIARINA FU),
T. Dale, and E. Dahl.
Fauna, Vol. 40, No. 3, p 98-103, 1987. 3 fig, 2 tab, 32 ref.

Descriptors: *Ciliates, *Norway, *Red tide, *Coastal waters, *Zooplankton, Phytoplankton, Wind, Downwelling, Algae.

A local red tide was observed in late November 1986 in parts of the bay Dybvag in southern Norway. The red tide lasted for less than a day. The discoloration was probably caused by red vacuoles in the planktonic ciliate Tiarina fusus. The ciliate occurred in extremely high densities (28,700 - 34,500 cells/ml). The frequency of cells in division of T. fusus was very low, only one among several hundred inspected. The cause of the mass occurrence is unclear, but the wind conditions and the low frequency of cells in division may suggest that T. fusus was concentrated in an area of downwelling. Except for some blooms by M esodinium rubrum observed in Oslofjorden in the late seventies, the present ciliate red tide is the second observed in Norway. The first one, due to oligotrichous ciliates, was observed in Flodevigen in May 1985, about 20 km to the west of Dybvag. (Author's abstract)
W88-09948

DISTRIBUTION OF FLORA AND FAUNA IN AN AREA RECEIVING PULP MILL EFFLUENTS IN THE BALTIC SEA,
Stockholm Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W88-09952

DENSITIES OF PROTOZOAN NANOPLANKTON POPULATIONS IN INTERTIDAL MESOCOSMS: INFLUENCE OF OIL POLLUTION AND A SELF-IGNITING CLEANING AGENT,
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5C.
W88-09953

COASTAL MANAGEMENT ISSUES FOR THE MOUTH OF THE RIVER MURRAY, SOUTH AUSTRALIA,
South Australia Dept. of Environment and Planning, Adelaide.
For primary bibliographic entry see Field 6E.
W88-09955

ECOLOGY OF PHYTOPLANKTON IN THE TVARMINNE AREA, SW COAST OF FINLAND: IV. ENVIRONMENTAL CONDITIONS, CHLOROPHYLL A AND PHYTOPLANKTON IN WINTER AND SPRING 1984 AT TVARMINNE STORFJARD,
Tvarminne Zoological Station (Finland).
A. Niemi, and A.-M. Astrom.
Annales Botanica Fennici ABOFAQ, Vol. 24, No. 4, p 333-352, 1987. 12 fig, 3 tab, 87 ref.

Descriptors: *Phytoplankton, *Chlorophyll A, *Plant growth, *Ecology, *Coastal waters, Seasonal variation, Nutrients, Baltic Sea, Finland.

The vernal phytoplankton development and its regulation by meteorological, hydrographical and chemical factors were investigated by means of frequent sampling in March-May. The total phytoplankton community, measured as chlorophyll a and biomass, and the dominant taxa were monitored, together with the hydrographical and nutri-

ent conditions. Besides a flagellate bloom below the ice in March, the vernal high production stage included seven different peaks of diatoms and dinoflagellates, the first in connection with the break-up of the ice and strong turbulence in mid-April, and the last ones in late May, caused by outflow of oligohaline surface water rich in nutrients from Pojo Bay. The study area in the outer archipelago has a strongly fluctuating environment, in which upwelling, mixing and outflow of surface water from Pojo Bay contributed the nutrients enabling several successive phytoplankton peaks, composed of a mixture of autochthonous and allochthonous assemblages at a different successional stages. After the break-up of the ice, the microphytoplankton chiefly consisted of Arctic, marine diatoms and Gonyaulax catenata. The outflow of oligohaline surface water in May was associated with the dominance of Diatoma elongatum, euryhaline marine diatoms, and in addition several freshwater diatoms. Nanoflagellates and picoplankton (Nannochloropsis sp.) were abundant during the whole study period, although their contribution to the total biomass was small during the diatom peaks. The proportion of colorless nanoflagellates increased markedly when the plankton assemblage declined in late May. In comparison with the conditions in 1969 and 1970, the nutrient level of the Baltic surface water had increased markedly in 1984. The silicate level, which in 1969/70 decreased in May to about 150 micrograms SiO4-Si/l now decreased to the detection limit. This points to raised nitrate and phosphate levels, and increased diatom production. (Author's abstract)
W88-09959

BEHAVIOR OF GROUNDWATER WITH DISPERSION IN COASTAL AQUIFERS,
Ehime Univ., Matsuyama (Japan). Dept. of Ocean Engineering.
For primary bibliographic entry see Field 2F.
W88-09975

STRUCTURE, DYNAMICS AND PRODUCTION OF MESOZOOPLANKTON COMMUNITY IN THE BOTHIAN BAY, RELATED TO ENVIRONMENTAL FACTORS,
Oulu Univ. (Finland). Bothian Bay Research Station.
P. Kankaala.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 2, p 121-146, 1987. 14 fig, 3 tab, 79 ref.

Descriptors: *Zooplankton, *Plankton, *Estuaries, *Ecosystems, Seas, Bays, Food availability, Biomass, Baltic Sea, Finland, Species composition, Population dynamics, Aquatic productivity.

Studies on the zooplankton community of the Bothian Bay, the northernmost basin of the Baltic Sea, were carried out in 1976-78. Only 8-14 taxa dominated in the zooplankton community. The high abundances and biomasses occurred during the warmest period or immediately afterwards, in July-September. The production of zooplankton was estimated to be 3.1-7.8 g times C/sq m times a in the coastal area and 2.5-3.6 g times C/sq m times a in the open sea. During the short growing season (June-September) the biomass turnover took place in about 11 days. The productivity of zooplankton is discussed in relation to available food of both autochthonous and allochthonous origin and compared with the other parts of the Baltic Sea. (Author's abstract)
W88-09993

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

DESALTING IRRIGATION AND ITS APPARATUS,
For primary bibliographic entry see Field 3F.
W88-10072

3B. Water Yield Improvement

CONCEPTS OF WELL CLEANING,
Bennett, Williams and Blattert, Inc., Indianapolis, IN.
O. J. Gottlieb, and R. E. Blattert.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 5, p 34-39, May 1988. 5 fig, 2 tab, 2 ref.

Descriptors: *Water yield improvement, *Well yield, *Clogging, *Cleaning, Rehabilitation, Groundwater, Chemical analysis, Soil analysis, Soil mechanics, Unconsolidated aquifers, Chemical treatment, Hydrochloric acid, Iron bacteria, Detergents, Piezometers.

Cleaning wells to restore or improve production requires an evaluation of the probable causes of clogging, which includes a chemical analysis of the groundwater and a mechanical analysis of subsurface soils. Once the probable cause or causes of clogging are determined, the most appropriate treatment can be prescribed. The authors discuss the principles involved in making such determinations for wells in unconsolidated formations. Hydrochloric acid should be used cautiously. If bacterially-precipitated iron is the cause of plugging, detergent should be added first and allowed to sit for several days; then chlorine bleach should be added. A more effective method of introducing cleaning agents to the well environment is through piezometers located around the well. Surging should accompany well cleaning, although it is possible to introduce chemicals and simply allow them to sit to prolong the time periods between full-scale cleaning operations. The restoration of a production well in Terre Haute, Indiana is described. (Shidler-PTT)
W88-09832

EVAPOTRANSPIRATION OF NATIVE VEGETATION IN THE CLOSED BASIN OF THE SAN LUIS VALLEY, COLORADO,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 2D.
W88-10032

EVAPOTRANSPIRATION OF PHREATOPHYTES IN THE SAN LUIS VALLEY, COLORADO,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 2D.
W88-10033

RECHARGE AS AUGMENTATION IN THE SOUTH PLATTE BASIN,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W88-10034

SIMULATION OF MICRO CATCHMENT WATER HARVESTING SYSTEMS,
Arizona Univ., Tucson. School of Renewable Natural Resources.
N. N. Namde.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8709896. Ph.D Dissertation, 1987. 140 p, 19 fig, 5 tab, 54 ref, 4 append.

Descriptors: *Model studies, *Water yield improvement, *Computer programs, *Water harvesting, *Catchment areas, *Hydrologic budget, *Rainfall-runoff relationships, Mathematical models, Runoff forecasting, Cultivated lands, Reservoirs, Optimization, Case studies.

An IBM-compatible personal computer model of a micro-catchment water harvesting system was developed for planners and designers. A sequential step water budget analysis device, the model contains a main program and catchment, cultivated area, and reservoir subroutines. The catchment subroutine calculates the runoff from rainfall on the catchment. The cultivated area subroutine calculates the amount of water available to a chosen crop by a soil water balance method. The reservoir subroutine uses a water balance method to calculate reservoir water content at the end of each period. The model was calibrated with hydrologic data and site characteristics for a location near Tucson, Arizona. Predictions of cotton and grain sorghum yields were comparable with those of Morin. Lack of direct rainfall and runoff duration and infiltration characteristics precluded the use of the model for weekly or monthly rainfall data for areas where daily data are unavailable. (Cremmins-AEPCO)
W88-10075

3C. Use Of Water Of Impaired Quality

CONJUNCTIVE USE OF BRACKISH COASTAL GROUND WATER BASINS IN SAN DIEGO COUNTY, CALIFORNIA,
San Diego State Univ., CA. Dept. of Geological Sciences.
For primary bibliographic entry see Field 4B.
W88-09244

USING UNDERGROUND ANTHRACITE MINE POOLS FOR MUNICIPAL WATER SUPPLIES: CASE STUDY - MT. CARMEL, PENNSYLVANIA,
Benatec Associates, Inc., Harrisburg, PA.
E. A. Dobson.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 759-771, 5 fig, 6 ref.

Descriptors: *Coal mines, *Acid mine drainage, *Water treatment, *Water supply development, Water reuse, Water quality, Pennsylvania, Reverse osmosis, Potable water, Case studies, Economic aspects.

The hydrogeologic and economic aspects of utilizing the vast quantities of groundwater contained within the abandoned underground deep mines of Pennsylvania's anthracite region as municipal water supplies were studied. Until recently, the aquifer potential of these mine pools has been largely ignored due to the impacts of 150 years of coal mining and the resultant acid mine drainage problems. A hydrogeologic investigation was conducted for the Borough of Mt. Carmel, Northumberland County, PA, to determine if supplemental groundwater sources could be added to their water system. The results of the hydrogeologic study showed that yields and water quality of the aquifer formations not associated with coal mining activities were such that development costs were prohibitive. In order to investigate all possible options, a feasibility study for the utilization of the mine pool waters underlying the Borough was undertaken. Based on the technical and economic studies of the data from the initial investigation, it was determined that it would be economically cost effective and technically feasible to treat the mine waters beneath the Borough for use as a potable water supply. This study has provided the impetus for further developmental studies utilizing the mine pool water reserves. Mine pool waters can serve as large volumes of either potable or industrial use waters, depending on the waters' treatability. (See also W88-09477) (Author's abstract)
W88-09519

SURVIVAL AND GROWTH OF SPIRULINA SPP. IN THE SALINE GROUNDWATERS OF NEW MEXICO,
New Mexico State Univ., Las Cruces. Energy Inst.
B. Goldstein.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-155890/AS. Price codes: A05 in paper copy; A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report 217, November 1986. 65 p, 19 fig, 5 tab, 29 ref.

State Project 1423610.

Descriptors: *Salinity, *Spirulina, *New Mexico, *Saline groundwater, Geothermal studies, Impaired water use, Salinity control.

New Mexico has some 15 billion acre-feet of saline groundwater. Much of this water has a salinity greater than 3,000 ppm Total Dissolved Solids (TDS) and thus cannot be used for potable water nor traditional agricultural activities. The main objective of the project was to determine the technical feasibility of growing Spirulina in New Mexico using these saline groundwaters. Spirulina was chosen because it grows naturally in highly alkaline lakes in hot climates and is more readily harvested than other algae. Spirulina has many potential uses as a source of specialty chemicals, feed ingredient for livestock and aquatic organisms, and human health food. Laboratory studies support empirical observations made at the pilot plant that several species of Spirulina will grow in full RTF saline water (14,000 ppm TDS), half RTF water (7,000ppm TDS), New Mexico State University (NMSU) geothermal water (2,000 ppm TDS) and NMSU tap water (500 ppm TDS). Further, these species are capable of excellent growth at temperatures as high as 42C. Growth appears to slow at 20C and below. The technical feasibility of Spirulina cultivation in New Mexico using saline groundwaters has been demonstrated. (Goldstein-NM St. Univ.)
W88-10038

EVALUATION OF AVAILABLE SALINE WATER RESOURCES FOR THE CONSTRUCTION OF LARGE-SCALE MICROALGAE PRODUCTION FACILITIES IN NEW MEXICO,
New Mexico State Univ., Las Cruces. Dept. of Agricultural Economics and Agricultural Business.
R. Lansford, J. Hernandez, P. Enis, and C. Mapel.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-155908/AS. Price codes: A03 in paper copy; A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report 218, December 1986. 36 p, 10 fig, 5 tab, 14 ref. Contract ZK-5-05091(SERI). State Project 1423657.

Descriptors: *Microalgae, *Saline water, *Microalgae potential production area, *New Mexico, *Basin management, Tularosa Basin, Estancia Basin, Crow flats, Pecos Basin, San Juan Basin, Tucumcari Basin.

The major objective of the research was to select potential sites for 2,470 acre microalgae production facilities in New Mexico using saline water resources. After a review of the location of the 15 billion acre-feet of saline water resources in the state, areas that appeared to generally meet the SERI criteria for site selection were narrowed to the following-the Tularosa Basin in south-central New Mexico, the Estancia Basin in central New Mexico, the San Juan Basin in northwestern New Mexico, the Tucumcari area in Quay County on the eastside of New Mexico, the area east of the Pecos River Basin in eastern New Mexico, and the Crow Flats area in southern New Mexico. A detailed analysis was completed for the six locations. Three basins were eliminated for failing to meet all the criteria developed for the study-Pecos Basin, San Juan Basin and the Tucumcari Area. Of the remaining basins, the Tularosa was judged best suited for a microalgae production facility, Crow Flats, the next best, and Estancia, the poorest of the three choices because of a short growing season. The reserves of saline waters ranging from 2.3 million acre-feet to 5.0 million acre-feet were identified for the large-scale microalgae production areas in New Mexico. (Lansford-NM St. U.)
W88-10039

3D. Conservation In Domestic and Municipal Use

METERING UTILITY SERVICES: EVALUATION AND MAINTENANCE,
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-09539

CONTROL OF PEAK WATER DEMANDS,
J. L. Hinchberger.
Public Works PUWOAH, Vol. 119, No. 6, p 78-79, June 1988. 1 fig.

Descriptors: *Water demand, *Peak demand, *User charges, Cost analysis, Water costs, Water rates, Water use, Cost savings, Ohio.

As a result of unexpected rapid growth in Butler County, Ohio, the reserve capacity in the supply, transmission, and storage facilities of the water supply system (built in the 1960's) was exhausted. In addition the peak demand to average day demand ratio increased from 1.3:1 in the 1960's to approximately 2.5:1 in 1980, with a peak of 10:1 by some customers. The water system was designed to satisfy peak demand up to approximately a 1.7:1 ratio. As a result of low water pressure and supply deficiencies, water restrictions were frequently imposed in the early 1980's. It was decided to impose peak use surcharges (premium rates) for customers placing extreme peak demands or willfully disregarding bans and restrictions. Base usages and acceptable variations were established and premium charges determined. The utility company implemented a more complicated billing, classification, and customer information system. Through this system Butler County was able to reduce the peak-to-average demand ratio from 2.5:1 to under 1.75:1, to finance needed improvements without increasing the base rate. (White-Reimer-PTT)
W88-09658

3F. Conservation In Agriculture

AGRICULTURE AND GROUNDWATER QUALITY.
Council for Agricultural Science and Technology, Ames, IA.
For primary bibliographic entry see Field 5B.
W88-08979

CONSERVING WATER IN IRRIGATION,
For primary bibliographic entry see Field 4B.
W88-09248

WATER CONSERVATION IN IRRIGATION--BENEFICIAL OR NOT,
For primary bibliographic entry see Field 4B.
W88-09249

HISTORICAL ASPECTS OF IRRIGATION AGRICULTURE AND RIVER REGULATION IN THE MURRAY-DARLING BASIN, AUSTRALIA,
Sydney Univ. (Australia).
For primary bibliographic entry see Field 6C.
W88-09723

ASSESSING IMPACTS OF IRRIGATION ON STREAMFLOW,
Michigan State Univ., East Lansing. Dept. of Civil and Environmental Engineering.
R. B. Wallace, and J. T. Pawloski.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 211-225, May 1988. 10 fig, 2 tab, 10 ref, append.

Descriptors: *Irrigation effects, *Streamflow depletion, *Stream discharge, *Environmental effects, Water quality, Watersheds, Selective withdrawal, Mathematical analysis.

A method for assessing the impacts on streamflow resulting from withdrawing water from the stream channel or from shallow wells adjacent to the stream for irrigation is based on a detailed study at a base station on the stream. Monthly irrigation demands are estimated and added to measured streamflow to determine the natural streamflow. The natural streamflow is correlated with flow on a nearby watershed to develop an extensive series of monthly flows. The procedure produces probability distributions for average monthly flow for each month of the growing season, for different levels of irrigation usage. The flow distributions include the original variation and the additional variation produced by the irrigation withdrawal. The streamflow information developed can be combined with biological or water quality models to assess the impacts of reduced flow on instream biology, water quality, and treatment requirements of waste discharged to streams. (Author's abstract)
W88-09733

FURROW FLOW MEASUREMENT ACCURACY,
Agricultural Research Service, Kimberly, ID.
For primary bibliographic entry see Field 7C.
W88-09735

INFLOW-OUTFLOW INFILTRATION MEASUREMENT ACCURACY,
Agricultural Research Service, Kimberly, ID.
For primary bibliographic entry see Field 2G.
W88-09736

MUSKINGUM MODEL FOR BORDER IRRIGATION,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh, P. D. Scarlatos, and S. A. Raudales.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 266-280, May 1988. 9 fig, 3 tab, 28 ref, 2 append.

Descriptors: *Routing, *Irrigation, *Model studies, *Muskingum model, Hydraulics, Mathematical studies, Continuity equation, Border irrigation, Infiltration.

A mathematical model for border irrigation was developed using the spatially lumped continuity equation and the Muskingum type storage relation. The storage parameter is determined from physical border characteristics. The model is calibrated and tested using twenty-four experimental data sets, and yields satisfactory results. The relative error in predicted advance is $< 16\%$ and that in predicted recession is $< 7\%$. A short comparison with three other models shows that the Muskingum model is comparable in accuracy. (Author's abstract)
W88-09737

TRICKLE LATERAL HYDRAULICS: I. ANALYTICAL SOLUTION.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
A. W. Warrick, and M. Yitayew.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 281-288, May 1988. 2 fig, 8 ref, append.

Descriptors: *Irrigation design, *Mathematical analysis, Trickle irrigation, Flow discharge, Hydraulics.

An important objective of any trickle system is a uniform distribution of water delivered through the emitters. Computation of flow distribution requires knowledge of the variables such as pressure, flow rate, length of lateral, characteristics of the orifices, and frictional loss in the system. Several studies have been reported that establish these relationships. In each study, the primary solution was based on a discharge that is uniform, although ramifications of the manufacturer's variability have been modeled based on the derived hydraulic profile. An alternative treatment includes a spatially variable discharge function as part of the basic solution and is valid for all emitter coefficients and all flow conditions from lateral to fully turbulent. (See also W88-09739) (Hammond-PTT)
W88-09738

TRICKLE LATERAL HYDRAULICS: II. DESIGN AND EXAMPLES,
Arizona Univ., Tucson. Dept. of Agricultural En-

gineering.
M. Yitayew, and A. W. Warrick.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 289-300, May 1988. 6 fig, 1 tab, 14 ref, 2 append.

Descriptors: *Irrigation design, *Mathematical analysis, Trickle irrigation, Flow discharge, Design criteria, Hydraulics.

The trickle lateral analysis described in the companion paper was used to illustrate applications of a new analytical solution in system design. Examples are provided to point out the basic concepts and procedures based on this and related analytical solutions. Very simple and yet powerful design curves for different flow regimes are presented. Verification of the solution was made by comparing the results with experimental measurements. The simplicity of the solution, coupled with the ease of including variable discharge, makes the analytical solution attractive for diversified uses in trickle system design. (See also W88-09738) (Author's abstract)
W88-09739

HYDROLOGIC IMPACTS OF IMPROVED IRRIGATION EFFICIENCIES,
Wyoming Univ., Laramie. Dept. of Agricultural Engineering.
S. K. Sando, J. Borrelli, and D. J. Brosz.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 334-342, May 1988. 5 fig, 2 tab, 10 ref, append.

Descriptors: *Irrigation effects, *Irrigation efficiency, *Sprinkler irrigation, *Streamflow, Hydrology, Watersheds, Agricultural watersheds, Flood peak, Salt River, Wyoming.

The Salt River drainage basin is an agricultural watershed of 2,150 square km in western Wyoming. Starting in 1971, several irrigation projects were completed that converted surface irrigation systems to sprinkler irrigation systems on approximately one-half of the irrigated land. This conversion resulted in less total water being diverted from streams for the sprinkler system than the previous surface system. Salt River stream flows were analyzed to determine if there were differences between the sprinkler systems prior to and after conversion. Mean monthly flows in May and June increased significantly (58.7%) following the conversion to sprinklers. The Salt River flows were also compared with flows of the Greys River, a nonagricultural watershed, using the double-mass analysis. The test again showed higher May and June flows. Lower fall flows were evidently a consequence of irrigation practices rather than climatological factors. Annual flood peaks increased significantly following the conversion to sprinklers. The mean annual flood peak increased by 47.0%. (Author's abstract)
W88-09743

TERMINOLOGY FOR DESCRIBING ON-FARM IRRIGATION WATER DEMANDS,
Calgary Univ. (Alberta). Dept. of Civil Engineering.
D. H. Manz.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 353-357, May 1988. 4 tab, 12 ref.

Descriptors: *Irrigation requirements, *Water demand, *Terminology, Classification, Conveyance systems.

The nature of the farm water demand irrigation that conveyance systems are to satisfy must be accurately defined. The determination and selection of a particular form of farm water demand will determine available design and operational options. Terminology is proposed for describing farm water demand which is a refinement of the Replogle and Merriam system. The modifiers used by Replogle and Merriam, which confused the relative flexibility of farm water demand with their method of determination, would be replaced. The proposed terminology describes the character of farm water demand from the perspective of conveyance system operations. Use of the terminology suggests variations which otherwise may not have been recognized. (Hammond-PTT)
W88-09745

USING CENTER PIVOTS FOR RESEARCH,
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
O. J. Helweg.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 358-362, May 1988. 3 fig, 7 ref.

Descriptors: *Center pivot, *Irrigation design, *Research facilities, *Design criteria, Trickle irrigation, Sprinkler irrigation, Mathematical analysis.

Most research to determine crop water-production functions can be divided into two types. One utilizes a random block design in which different amounts of water are applied to small blocks (basins). The other is a line-source sprinkler irrigation system where a line of sprinklers is placed in the center of a field; it delivers a continuously decreasing depth of water as the distance from the line of sprinklers increases. A study was conducted using a center pivot that had been modified for the traveling trickler system. It proved to be an excellent experimental pivot for calculating a crop production function. Adjustable emitters may be set to give uniform application rate within a set band. The emitters also give greater control and flexibility in the experiment. The width of the band may be adjusted to obtain equal plot areas. The inaccuracies of catch cans needed for a line sprinkler experimental plot are eliminated. (Hammond-PTT)
W88-09746

SEASONAL VARIATIONS ON WATER RELATIONS OF AMYGDALUS COMMUNIS L. UNDER DRIP IRRIGATED AND NON-IRRIGATED CONDITIONS,
Centro de Edafologia y Biologia Aplicada del Segura, Murcia (Spain).
A. Torrecillas, M. C. Ruiz-Sanchez, F. Del Amor, and A. Leon.
Plant and Soil PLSOA2, Vol. 106, No. 2, p 215-220, February 1988. 5 fig, 1 tab, 25 ref. CAICYT Grant No. 957.

Descriptors: *Leaf water potential, *Almond trees, *Drip irrigation, *Amygdalus communis L., *Irrigation effects, Leaves, Capillary conductivity, Rainfall, Hysteresis, Evapotranspiration, Aging, Deciduous trees, Rainfall, Seasonal variation.

Almond plants (Amygdalus communis L.) of the Garrigues variety were grown in the field, drip irrigated and rainfed. Leaf water potential (psi) and leaf conductance (g sub l) were determined throughout one growing season. Pre-dawn measurement for psi in the irrigated treatment was consistent through the growing seaaon, whereas in the rainfed treatment it decreased gradually. Psi values at midday (psi minimum) was closely dependent on atmospheric evaporative demand, and their recovery was quicker in the wet treatment than in the dry. The g sub l values were higher in the wet than dry treatments, decreasing in both cases by leaf aging. Maximum values for g sub l were reached when evaporative demand was highest in the day. The relationship between psi and g sub l revealed a decrease in the hysteresis throughout the growing season, being most marked in the dry treatment. The results highlight the close dependence of psi and g sub l on evaporative demand, leaf aging and irrigation treatment during the growing season. (Author's abstract)
W88-09898

COMPUTER-AIDED APPROACH TO AGRICULTURAL FLOOD HAZARD MANAGEMENT IN FLORIDA.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6A.
W88-10015

SOMATIC CELL SELECTION CRITERIA FOR WATER USE EFFICIENCY USING GENETICALLY DIFFERENTIAL ALFALFAS,
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
G. C. Phillips.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-161070/AS. Price codes: A03 in paper copy; A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report No. 221, May 1987. 30 p, 7 tab, 30 ref. Contract No. 14-08-0001-G1033. Project No. USGS G1033-04. State projects 1423650 and 1423653.

Descriptors: *Alfalfa, Water use efficiency, *Growth rates, *Osmotic stress, *Cell cultures, Crops, Plant breeding, Genetics, Plant tissues, Culture, Water conservation.

Development of crops that are water use efficient would make an important contribution to the conservation of this critical resource. Laboratory methods of genetic engineering, such as somatic cell selection, promise to be faster and more precise in the development of water use efficient crops compared to conventional breeding, provided that appropriate selection criteria can be identified. This project attempted to define somatic cell selection criteria by using a series of genetically related alfalfa populations bred by conventional methods to be increasingly more water use efficient. The preliminary data generated by this project lend support to the following conclusions: (1) cell survival under osmotic stress was not an adequate cell selection criterion for genetic improvement of water use efficiency; and (2) titers of polyamines in cell cultures and whole-plants under stress corresponded to the degree of water use efficiency known to exist in the respective parental populations. If polyamine titers represent biochemical indices of water use efficiency, they could be used to devise an appropriate whole-plant or cell selection strategy. (Phillips-NM St. Univ.)
W88-10021

EFFECTS OF TILLAGE SYSTEM, CROP RESIDUE LEVEL, AND FERTILIZER APPLICATION TECHNIQUE ON LOSSES OF PHOSPHORUS AND PESTICIDES FROM AGRICULTURAL LANDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W88-10025

EVALUATION OF THE POTENTIAL TO IMPROVE ALFALFA FOR PRODUCTION UNDER LESS THAN OPTIMUM MOISTURE CONDITIONS,
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
C. Currier, B. Melton, and M. Wilson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-155916/AS. Price codes: A04 in paper copy; A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report 222, May 1987. 58 p, 24 tab, 29 ref. State Project 1423649.

Descriptors: *Drought, *Water conservation, *Plant breeding, *Alfalfa, Irrigation, Forage, Management, Crop production, New Mexico.

The use of alfalfa was explored as a means of conserving New Mexico's supplies of fresh water. Plant breeding procedures were used to increase alfalfa's yield potential when given limited quantities of irrigation. Field, greenhouse, and laboratory experiments were conducted to find techniques that would: identify germplasm sources for these traits; evaluate and identify individual genotypes within these sources; evaluate the potential of the techniques and the new populations developed; and evaluate irrigation management techniques that would maximize the yield potential of the selected populations with less than optimum amounts of irrigation. Germplasm sources, selection techniques, elite genotypes, and irrigation

management techniques were developed. The result is that water conservation is feasible with alfalfa with little sacrifice in yield potential. The selected population produced more forage than unselected populations when given the same amount of water. The advantage of the selected populations was greatest at the lower levels of irrigation. Alfalfa appeared to have a greater response to water applied early in the growing season than late. The combination of selected populations and irrigation management allows for maximum water conservation with alfalfa. (Currier-NM St. U.)
W88-10040

IRRIGATION MANAGEMENT PROCEDURES TO MAXIMIZE PRODUCTION OF ALFALFA POPULATIONS SELECTED FOR INCREASED PERFORMANCE UNDER DEFICIT LEVELS OF IRRIGATION,
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
C. Currier, B. Melton, and J. Mayernak.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-155924/AS. Price codes: A03 in paper copy; A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report 225, September 1987. 31 p, 2 fig, 6 tab, 14 ref. Contract 14-08-0001-G1241(03). Project USGS G1241-03. State Project 1423662.

Descriptors: *Water use efficiency, *Crop yield, *Alfalfa, *Irrigation water use, Plant populations, Drought, Forage, Moisture stress, Irrigation management.

Availability and cost of irrigation water is a major consideration in crop production in most arid and semi-arid parts of the world. This study was conducted to evaluate selected populations of alfalfa (Medicago sativa L.) for increased performance with deficit levels of irrigation and to determine the effects of irrigation rates and sequences on forage yield and performance of these selected populations. Selection for increased performance under deficit levels of irrigation increased yield under all irrigation treatments. Forage yields obtained with 20 inches of annual irrigation were reduced approximately 40-45 percent as compared to 40 or 60 inches of irrigation annually. Yields from 40 and 60 inch rates of irrigation were similar with a higher stand density at the end of the third production year in the 40 inch plots. Yields from the early and spread irrigation sequences were similar and indicated that no yield advantage was obtained from the early season applications of irrigation water. However, modifications of seasonal yield patterns, and possible labor savings due to harvest costs, should be investigated further by economic analysis. (Currier-NM St. U.)
W88-10041

DESALTING IRRIGATION AND ITS APPARATUS,
Y. Tsuruta.
U. S. Patent No. 4,572,706; February 25, 1986, 6 p, 3 fig. Official Gazette of the United States Patent Office, Vol 1063, No 4, p 1798, February 25, 1986.

Descriptors: *Patents, *Desalination, *Surface irrigation, *Irrigation engineering, Casings, Water conveyance, Water supply, Absorption, Leaching, Irrigation water.

Plants are irrigated from the surface by infusing water into the soil to a root region using an airtight casing. The casing contains an open bottom, which is essentially sealed to the soil surface. The water is infused into the soil through a filler material within the casing from the upwardly opening outlet of a water supply receptacle in the casing. Water is supplied to the receptacle from a water source below the opening outlet. A salt absorbing material is placed between the outlet and the plant roots. The infusion water is passed through the salt absorbing material between the outlet and the roots at a rate that is sufficiently low to remove salt from the infusing water and to prevent leaching from the salt absorbing material. (Cremmins-AEPCO)
W88-10072

VARIABLE POROSITY IRRIGATION PIPE,
Dasurat Enterprises Ltd., Singapore.
J. W. Mason.
U. S. Patent No. 4,615,642; October 7, 1986, 9 p, 5 fig, 4 tab. Official Gazette of the United States Patent Office, Vol 1071, No. 1, p 218, October 7, 1986.

Descriptors: *Patents, *Pipes, *Irrigation engineering, *Porosity, *Leakage, Flexibility, Resins, Elastomers, Subsurface irrigation.

A uniform leak-rate irrigation pipe comprises a porous, flexible pipe with inlet and outlet ends. The pipe contains a wall formed primarily of vulcanized elastomer particles dispersed in a thermoplastic resin binder. The wall contains a continuous pattern of pores and controllably increases from the inlet to the outlet end so that the leak rate is relatively constant as the pressure drops from the inlet to the outlet end. The porous pipe is especially useful in large fields where the costs of manifolds, associated pumps, and energy are expensive. (Cremmins-AEPCO)
W88-10074

SIMULATION OF MICRO CATCHMENT WATER HARVESTING SYSTEMS,
Arizona Univ., Tucson. School of Renewable Natural Resources.
For primary bibliographic entry see Field 3B.
W88-10075

VAPOR BUDGET MEASUREMENT OF EVAPORATION FROM IRRIGATED SURFACES,
Clemson Univ., SC. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2D.
W88-10088

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

IMPERMEABILIZATION OF A 300-HECTARE COOLING POND,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ingenieria.
For primary bibliographic entry see Field 2G.
W88-09442

EFFECTS OF RIVER REGULATION ON FLOODING OF A RIPARIAN RED GUM FOREST ON THE RIVER MURRAY, AUSTRALIA,
Melbourne Univ., Parkville (Australia). Forestry Section.
L. J. Bren.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 65-77, April-June 1988. 10 fig, 2 tab, 26 ref.

Descriptors: *Regulated rivers, *Dam effects, *Flood plains, *Water management, *Flooding, *Plant populations, *Riparian vegetation, Flood frequency, Water control, Floods, Rivers, River Murray, Australia, River flow, Distribution patterns, River regulation, Correlation analysis, Succession.

Forests of river red gum (Eucalyptus camaldulensis Dehnh.) occur along the River Murray in Australia. These forests are important for biota, recreation, grazing, and wood products. They occur in a sub-humid to semi-arid environment and require flooding for adequate growth and regeneration, The largest continuous area is the Barmah (Victoria) and Millewa (New South Wales) forest near Echuca (Victoria). Information from maps showing the extent of inundation of Barmah Forest for particular floods was related to flow data upstream of the forest, and maps showing the distribution of vegetation and forest site quality. Vegetation associations occurred in characteristic flood frequency ranges, with red gum being the dominant species on all but the highest and lowest flood frequency sites. Higher red gum site quality was associated with higher frequency of flooding. The extent of flooding depended on the magnitude of peak flows in the river. Regulation of the river since the first filling of Hume Dam in 1934 has caused a reduction in the frequency of flows associated with partial flooding and an increase in the occurrence of small summer floods. Areas with high flood frequency were most affected. The forest may change to types associated with reduced duration of inundation in the long-term unless ameliorative action is taken. (Author's abstract)
W88-09718

MODIFICATION OF TEMPERATURE BEHAVIOUR THROUGH REGULATION OF A BRITISH RIVER SYSTEM,
Exeter Univ. (England). Dept. of Geography.
B. W. Webb, and D. E. Walling.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 103-116, April-June 1988. 7 fig, 3 tab, 22 ref.

Descriptors: *Water management effects, *Regulated rivers, *Water temperature, *Flow control, *Rivers, Temperature, Reservoirs, Reservoir releases, River systems, River Exe, England, Base flow, Seasonal variation.

The effects of flow regulation on temperature behavior in the River Exe, Devon, U.K., were studied, with attention given to the local impact of impoundment and its downstream persistence. Temperature levels and seasonal thermal regime were considered as well as diel temperature fluctuations and temperatures during extreme weather conditions. Variations in temperature during individual reservoir releases were monitored. The impact of impoundment was to make the stream environment immediately below the dam more homothermous so that temperatures rarely rose above 17.5 C or fell below 2.0 C, and monthly average diel ranges were <3 and <1 C in summer and winter months, respectively. In contrast to other reservoirs in Britain and abroad, this effect was largely caused by increased groundwater flow downstream from the reservoir following impoundment. Regulation also affected downstream temperature behavior and moderated the thermal regime of the Exe mainstream. This influence was generally restricted to a distance of up to 20 km from the dam, but in conditions of hot weather and low flows it may extend to almost 40 km from the impoundment. Individual reservoir releases varied in their ability to influence downstream temperature behavior, and degree of persistence in the river network increased with the size of the release. (Wood-PTT)
W88-09721

FLOOD ALLEVIATION OF THE KAKEHASHI BASIN, JAPAN,
Kanazawa Inst. of Tech. (Japan). Dept. of Mechanical System Engineering.
T. Nakagawa.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 187-193, April-June 1988. 8 fig, 4 ref.

Descriptors: *Flood control, *Floodproofing, *Water control, *River basins, *Hydraulic structures, Dams, Retarding basins, Diversion channels, Kakehashi basin, Kakehashi River, Japan, Water management effects.

A flood alleviation scheme is proposed for the Kakehashi basin, Japan. The scheme consists of one diversion channel, four retarding basins and one dam. The region between the diversion channel and the Kakehashi river is protected from floods. The measures proposed make it possible to achieve flood alleviation while minimizing changes of the Kakehashi river, and impacts on historical environments and cultural properties. It is emphasized that preservation of the sinuous channel of

the Kakehashi river must play a key role in future management because of the physical, biological and aesthetic advantages when compared with a straight stream channel. (Author's abstract)
W88-09729

EFFECTS OF RIPRAP BANK REINFORCEMENT ON JUVENILE SALMONIDS IN FOUR WESTERN WASHINGTON STREAMS,
Fish and Wildlife Service, Olympia, WA. Fisheries Assistance Office.
For primary bibliographic entry see Field 8I.
W88-09820

SUPPRESSION OF WATER HYACINTH BY THE EXOTIC INSECT NEOCHETINA EICHHORNIAE IN BANGALORE, INDIA,
Indian Inst. of Horticultural Research, Bangalore.
K. P. Jayanth.
Current Science, Vol. 56, No. 10, p 494-495, May 1987. 8 ref.

Descriptors: *Weed control, *Water hyacinth, *Biocontrol, *Aquatic weeds, *Aquatic insect, Field tests, Plant growth, India.

Water hyacinth (Eichhornia crassipes), a free-floating plant of South American origin and considered to be one of the world's most serious aquatic weeds, infests more than 200,000 ha of the water surface in India. Neochetina eichhorniae Warner (Coleoptera: Curculionidae), one of the natural enemies identified in surveys conducted in South America, was tested in 1982. Field releases were started in Bangalore after exhaustive host-specificity tests conducted under quarantine conditions confirmed its safety for field liberation in India. The increase in the population of N. eichhorniae was accompanied by a reduction in the petiole length of water hyacinth plants. At the start of the experiment the length of the petioles varied between 59 and 65 cm which declined to 32 and 43 cm in December 1985. Around this time water hyacinth leaves started browning and by March 1986 extensive browning could be noticed. There was progressive reduction in the area covered by water hyacinth and by June 1986 this had reduced by about 50%. The results obtained so far indicate that N. eichhorniae is capable of bringing about biological control of water hyacinth. Distribution of this insect to other parts India holds promise of control of this noxious weed. (Alexander-PTT)
W88-09945

MULTIOBJECTIVE RESERVOIR OPERATION USING FORECASTS OF WATER SUPPLY AND WATER USE,
Interstate Commission on the Potomac River Basin, Rockville, MD.
For primary bibliographic entry see Field 6A.
W88-10018

INFLUENCE OF SPATIAL VARIABILITY AND SCALE EFFECTS ON THE PARAMETERIZATION OF HYDROLOGIC RESPONSE,
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 2E.
W88-10024

UNDERGROUND DRAIN PIPE,
S. Kanao.

Descriptors: *Patents, *Subsurface drainage, *Drainage systems, *Pipes, *Culverts, Conveyance structures, Drainage engineering, Underground structures.

Underground water is conducted to a disposal channel using a culvert drain pipe. The pipe is composed of a U-shape band strengthening member wound in a spiral. The open side is directly inwardly and a gap exists between the edges. A band of material having small holes in its center is wound between adjacent edges. The continuous side edges of the band are joined to the edges of the strengthening member. The underground drain pipe provides improved soil pressure resistance. (Cremmins-AEPCO)
W88-10070

VERTICAL DRAIN,
O. Wager.
U. S. Patent No. 4,622,138; November 11, 1986, 6 p, 9 fig. Official Gazette of the United States Patent Office, Vol 1072, No 2, p 673, November 11, 1986.

Descriptors: *Patents, *Drains, *Subsoil drains, *Saturated soils, *Drainage engineering, *Soil water, Dewatering, Vertical flow, Filter media, Fabrics, Compressibility.

A vertical drain for dewatering saturated, compressible soils can be folded straight across longitudinally to expose at least two sides at an angle to catch the radial flow of water to the drain. Two elongated bands are joined to open and form a partially cross-shaped cross section. Each band contains a core covered by a filter fabric. The cores' longitudinal channels are intersected by transverse channels extending perpendicularly. The fabric of the bands is joined longitudinally so that they may be folded together or spread apart. The rectangular cross section of the bands allows them to be rolled up for storage. (Cremmins-AEPCO)
W88-10073

USE OF STOCHASTIC DYNAMIC PROGRAMMING FOR OPTIMUM RESERVOIR MANAGEMENT,
California Univ., Los Angeles. School of Engineering and Applied Science.
For primary bibliographic entry see Field 6A.
W88-10086

4B. Groundwater Management

RCRA GROUND WATER MONITORING TECHNICAL ENFORCEMENT GUIDANCE DOCUMENT (TEGD).
National Water Well Association, Dublin, Ohio.
September 1986. 317 p, 33 fig, 53 ref, 3 append.

Descriptors: *Environmental policy, *Enforcement, *Groundwater management, *Monitoring, *Standards, Geohydrology, Wells, Sampling, Statistical analysis, Assessments, Construction, Design standards.

This publication describes in detail what the US Environmental Protection Agency (EPA) deems to be the essential components of a groundwater monitoring system that meets the goals of the Resource Conservation and Recovery Act. This guidance is intended to be used by enforcement officials, permit writers, field inspectors and attorneys at the federal and state levels to assist them in making informed decisions regarding the adequacy of existing or proposed groundwater monitoring systems or modifications. It is not a regulation and should not be used as such. This guide is divided into six chapters which contain discussions on the following: (1) Characterization of site geohydrology; (2) Location and number of groundwater monitoring wells; (3) Design, construction and development of groundwater monitoring wells; (4) Content and implementation of the sampling and analysis plan; (5) Statistical analysis of groundwater monitoring data; and (6) The content and implementation of the assessment plan. (Lantz-PTT)
W88-08976

INTRODUCTION TO ARTIFICIAL GROUNDWATER RECHARGE,
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
W. A. Pettyjohn.
National Water Well Association, Worthington, Ohio. 1981. 44 p, 23 fig, 18 ref.

Descriptors: *Groundwater recharge, *Artificial recharge, Infiltration, Aquifers, Groundwater management, Groundwater budget, Recharge wells, Wastewater, Irrigation, Groundwater storage, Well yield, Saline water intrusion, Wastewater renovation, Water spreading, Groundwater, Groundwater depletion, Subsidence, Stream flow, Municipal wastewater, Irrigation water.

Artificial groundwater recharge has been practiced for scores of years throughout the world. The purpose of artificial recharge is to increase the rate at which water infiltrates the land surface in order to supplement the quantity of groundwater in storage. A variety of recharge techniques are feasible. Examples include methods that increase well yields, reduce the rate of decline of groundwater levels, reduce land subsidence, control seawater intrusion in coastal areas, and renovate wastewaters. Two broad types of artificial recharge are water spreading and well systems. In the water spreading system, large areas of land may be flooded, basins constructed, ditches or furrows excavated, or existing stream channels modified. Water is diverted to these structures where it infiltrates. Recharge wells consist of shallow, relatively large pits or shafts or screened wells. Waters used for recharge commonly include stream flow, municipal wastewaters, excess irrigation water, and cooling water. Examples of successful recharge projects and experiments in the United States have been reported from Illinois, Ohio, North Dakota, Michigan, Arizona, New York, and particularly California, among several others. (Author's abstract)
W88-08980

WATER SYSTEMS HANDBOOK: A COMPLETE TEXT ON PRIVATE WATER SYSTEMS - THEIR DESIGN, OPERATION AND MAINTENANCE.
Water Systems Council, Chicago, IL.
For primary bibliographic entry see Field 5F.
W88-08984

CONSTRUCTION DEWATERING: A GUIDE TO THEORY AND PRACTICE,
Moretrench American Corp., Rockaway, NJ.
For primary bibliographic entry see Field 8B.
W88-08989

BASIC DATA REPORT, DRILLING AND WELL INSTALLATION AT TEST SITES MSB-12 AND MSB-34.
Geraghty and Miller, Inc., Tampa, FL.
For primary bibliographic entry see Field 2F.
W88-09088

PROCEEDINGS OF THE THIRD NATIONAL SYMPOSIUM ON AQUIFER RESTORATION AND GROUND-WATER MONITORING.
National Water Well Association, Worthington, OH.
Columbus, Ohio. May 25-27, 1983. National Water Well Association, Worthington, OH. 1983. 461 p. Edited by D. M. Nielsen.

Descriptors: *Groundwater management, *Water quality control, *Rehabilitation, *Monitoring wells, *Groundwater pollution, *Aquifer testing, *Water pollution treatment, *Monitoring, Well casings, Case studies, Test wells, Waste recovery, Remedies, Chemical recovery, Mathamatical models, Groundwater movement, Groundwater hydrology, Geologic fractures.

The Third National Symposium on Aquifer Restoration and Ground-Water Monitoring was held in Columbus, Ohio, May 25-27, 1983. The symposium covered a wide range of topics including physical containment methods, remediating hydrocarbon contamination, remedial action in fractured rock, evaluating remedial action, monitoring program/system design, monitoring well design, groundwater sampling and analysis, geophysical techniques in monitoring, safety in hazardous waste-site investigations and case histories. (See W88-09130 thru W88-09180) (Author's abstract)
W88-09129

PROCEEDINGS OF NWWA WESTERN REGIONAL CONFERENCE ON GROUND WATER MANAGEMENT.
National Water Well Association, Worthington, OH.
San Diego, California, October 23-26, 1983. Sponsored by the National Water Well Association. National Water Well Association, Worthington, OH. 1984. 369 p.

Descriptors: *Groundwater management, *Conjunctive use, *Recharge, *Artificial recharge, *Irrigation, * Water quality control, *Model studies, *Water law, *Protection, *Water supply.

Topics discussed in a conference on management of groundwater supplies and quality were conjunctive use of groundwater and surface water in the dry western states, artificial groundwater recharge experiences, water quantity and quality management in irrigation, use of models in groundwater supply management, strategies for groundwater management in the western states, groundwater law (including the Sporhase decision), and plans for protection of groundwater quality. (See W88-09241 thru W88-09282) (Cassar-PTT)
W88-09240

CONJUNCTIVE USE--FIRST BY ACCIDENT, NOW BY MANAGEMENT,
Nebraska Dept. of Water Resources, Omaha.
H. L. Becker, and R. D. Kuzelka.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 3-6, 4 fig, 5 ref.

Descriptors: *Groundwater management, *Water law, *Conjunctive use, *Nebraska, *Irrigation, *Diversion, *Recharge, Groundwater recharge, Water storage, Platte River, Lake McConaughy, Water supply, Rivers, Legislation, Beneficial use, Appropriation, Artificial recharge, Water use.

The Platte River Valley, Nebraska, is a prime example of a conjunctive use system in operation. Through inadvertent seepage losses from the operation of the Central Nebraska Public Power and Irrigation District, 7 million acre-feet of water is in storage underlying the district's irrigated lands. Farmers have tapped this augmented groundwater supply through private wells for several reasons: more efficient pumps, center pivot systems, and occasional inability of the District to supply full water needs. In the past, the use of surface water to recharge the groundwater supply has not been recognized by Nebraska law. LB 198, passed by the state legislature in 1983, recognizes not only that recharge of the groundwater reservoir could be incidental to existing surface water projects but also that such recharge could be included as a beneficial use of surface water in future water projects. This legislation authorized that the entity which caused the augmentation could charge a fee to those who benefit from the supplementation. (See also W88-09240) (Cassar-PTT)
W88-09241

CONJUNCTIVE USE AND GROUND WATER MANAGEMENT IN ORANGE COUNTY, CALIFORNIA,
D. E. Williams.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 8-15, 10 fig.

Descriptors: *California, *Groundwater management, *Conjunctive use, *Water use, *Irrigation, *Diversion, *Recharge, Groundwater recharge, Orange County, Santa Ana River, Water supply, Rivers, Model studies, Saline water intrusion, Encroachment, Colorado River, Wells, Injection wells, Wastewater disposal, Aquifers, Coastal aquifers, Water spreading, Water storage, Artificial recharge.

The Orange County Water District, between the Santa Ana Mountains and the Pacific Ocean, obtains 60% of its supply from ground water. To meet the demands of a rapidly growing population, complex water supply and management problems have been solved by underground storage of water imported from the Colorado River and northern California. Since 1949 the district has artificially recharged about 5 million acre-feet of water in the groundwater reservoirs of the 325-mile square basin, using numerous on and off channel recharge facilities. In the upper reaches of the Santa Ana River, impoundments slow the flow so that percolation into the highly permeable soils is facilitated. In addition, several large reservoirs have been constructed near the river: 1100 acres of spreading facilities including Warner Basin (90 acres, 50 ft deep) and Anaheim Lake (70 acres). The sea water encroachment problem in the coastal areas of the county is managed with a battery of injection wells. Water for injection into the wells at the Alamitos Barrier (17 wells, 300-500 ft apart) is supplied by 40% northern California water and 60% Colorado River water; here, 700 acre-feet of salt water were extracted and 4900 acre-feet of fresh water were injected during 1981-1982. At the Talbert Barrier (23 injection wells) water for injection is obtained from an advanced wastewater reclamation facility capable of producing 15 mgd of water which meets drinking water standards. A computer mathematical model is used to manage the water programs. The model accounts for the two main layers of the basin with vertical leakage between layers. Most of the recharge occurs where the two layers merge into a single common zone. (See also W88-09240) (Cassar-PTT)
W88-09242

CONJUNCTIVE USE OF GROUND WATER AND SURFACE WATER IN THE SOUTH PLATTE RIVER BASIN--A CASE STUDY OF THE CENTRAL COLORADO WATER CONSERVANCY DISTRICT,
Central Colorado Water Conservancy District, Greeley.
T. V. Cech.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 16-21, 12 ref.

Descriptors: *Surface water, *Groundwater management, *Conjunctive use, *Colorado, *Water law, *Water use, *Diversion, *Recharge, *Irrigation wells, Groundwater recharge, Central Colorado Water Conservancy District, Water supply, Rivers, Appropriation, Water rights, Wells, Injection wells, Wastewater disposal, Flow augmentation, Water spreading, Water storage, South Platte River, Artificial recharge, Water allocation, Case studies.

The Doctrine of Prior Appropriation was adopted in the late 19th century in Colorado, allocating surface water to irrigators based on the date of their appropriation. This law created poor management of scarce water resources. The 1957 Act instituted a permitting process and laid the framework for administration of groundwater in the state. The Ground Water Management Act of 1965 regulated non-tributary groundwater and formed districts to manage groundwater within the designated basins. The Water Right Determination and Administration Act of 1969 placed irrigation wells under the priority system. In effect, the law requires all tributary irrigation wells to shut down during periods when water is needed to maintain surface water flow. Since the economy of eastern Colorado relies heavily on the 10,000 tributary irrigation wells of the South Platte River, these wells are allowed to pump only if they replace 5% of pumped water back into the river for surface irrigators. The Central Colorado Water Conservancy District formed a Ground Water Management Subdistrict in 1973 to provide a mechanism for administrating the allocation and replacement of this augmentation water so that irrigation wells could continue to pump. Six thousand acre-feet of water are acquired each year for augmentation. The district owns and leases ditch company stock, has a battery of wells that pump directly into the South Platte River, and is developing a series of small reservoirs to capture spring runoff for augmentation during low flow months. (See also W88-09240) (Cassar-PTT)
W88-09243

CONJUNCTIVE USE OF BRACKISH COASTAL GROUND WATER BASINS IN SAN DIEGO COUNTY, CALIFORNIA,
San Diego State Univ., CA. Dept. of Geological Sciences.
D. Huntley, and F. A. Carroll.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 22-27, 8 fig, 1 tab, 6 ref.

Descriptors: *Groundwater management, *Impaired water use, *Conjunctive use, *Water use, *Coastal auifers, *Groundwater basins, *Brackish water, *Recharge, Groundwater recharge, Water storage, San Diego County, California, Water supply, Rivers, Artificial recharge, Saline water, Wells, Model studies, Desalination, Saline water intrusion, Aquifers, Connate water, Imported water.

Conjunctive use of surface water and brackish groundwater is being explored as a water supply source for San Diego County, California. Coastal and near-coastal groundwater basins with significant alluvium occupy 125 sq mi and contain up to 750,000 acre-feet of brackish groundwater. Five of 14 alluvial basins were considered most practical for further development. Salinity of the water is 1,000-25,000 mg/liter, with most in the 1000-3000 mg/liter range. Sources of the water include connate sea water and irrigation return water. The basic strategy for conjunctive use involves pumping and desalination of the brackish groundwater and artificial recharge with excess flood waters and imported water obtained during periods of low use and high availability. A numerical model was used to evaluate the feasibility of the proposed scheme. The San Dieguito Basin was used as a sample model study. In this aquifer recharge occurs from seepage from the upper San Dieguito River, rainfall infiltration, and sea water intrusion. Groundwater discharge is to wells, the lower sections of the San Dieguito River, and the ocean. The basin has a potential water storage of 52,000 acre-feet with variable water quality (chloride concentrations in 1965 were 300-14,000 mg/liter). Some of the problems seen in this basin include very irregular discharge availability, sea water intrusion, saline water recharge from marine sedimentary rocks, and saline connate water in the unconsolidated deposits. (See also W88-09240) (Cassar-PTT)
W88-09244

GROUND WATER RESERVOIR MANAGEMENT THROUGH ARTIFICIAL RECHARGE--FACT OR FANTASY,
W. C. Bianchi, and D. Cehrs.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 31-35.

Descriptors: *Groundwater management, *Recharge, *Water storage, *Groundwater reservoirs, *Artificial recharge, Groundwater recharge, Suspended solids, Water treatment, Injection wells, Wells, Wastewater disposal, Groundwater pollution.

Although the technology for artificial recharge is available, it is not widely applied. The clogging phenomenon is a major consideration. Suspended solids in the raw water for recharge must be removed by high flow treatment techniques and/or surface storage before percolation or injection in permanent recharge facilities. Even though these treatment costs are significant, they compete with surface storage costs in today's water market. Presently, groundwater recharge is best justified as a secondary benefit to wastewater treatment, recreation, or flood control. Recharge must be justified

on its own merits through development of a water value system that considers that water reserves are being depleted. Current recharge technology is based on very low costs; but research must not be restricted to low-cost methods. Recharge technology that needs further study includes the use of specific crops over-irrigated for recharge, the development of new water treatment and well technology for injection into alluvial aquifers, the application of these treatment techniques to maintain high intake rates in spreading areas, and the expansion of induced recharge approaches. (See also W88-09240) (Cassar-PTT)
W88-09245

GROUND WATER RECHARGE IN SASKATCHEWAN--A HISTORICAL REVIEW AND AN ASSESSMENT OF POTENTIAL,
Saskatchewan Univ., Saskatoon. Coll. of Engineering.
J. A. Gillies.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 36-46, 3 fig, 3 tab, 21 ref, append.

Descriptors: *Groundwater potential, *Groundwater management, *Recharge, *Water storage, *Artificial recharge, Saskatchewan, Groundwater recharge, Injection wells, Wells, Rural areas, Aquifers, Water quality, Reviews, Canada.

In Saskatchewan, groundwater is contained in three general types of aquifers: bedrock (low sustained yields of soft, highly mineralized water), preglacial valley aquifers (large yields of hard, highly mineralized water), and surficial or drift aquifers (large variations in yield and water quality). Recharge is a possible answer to alleviating these problems. Preliminary work on small-scale projects was done, but no measure of long-term success was undertaken. If spring snowmelt or excess rainfall could be stored underground on a large scale, the problems of water supply in rural areas could be eased. Seven operating municipal recharge projects are in operation. Six of these use seepage basins to recharge shallow aquifers in which municipal wells are installed. The seventh operates by injecting desalinated water into a deep aquifer. (See also W88-09240) (Cassar-PTT)
W88-09246

ARTIFICIAL RECHARGE POTENTIAL IN THE FRESNO AND MADERA IRRIGATION DISTRICTS,
D. Cehrs, and W. C. Bianchi.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 47-55, 8 fig, 1 tab, 13 ref.

Descriptors: *Groundwater management, *Recharge, *Water storage, *Irrigation water, *Diversion, *Artificial recharge, Groundwater recharge, Fresno Irrigation District, Madera Irrigation District, California, Rivers, Water table, Groundwater pollution, Wells.

Surface irrigation from diverted river water began in 1866 in the Fresno-Madera area. The first groundwater problems arose in 1882 when overirrigation in the Central California Colony brought the water table to within 3 ft of the surface. The water table below the Fresno-Madera area remained within 10-15 ft of the surface until 1946 when agricultural pumping began in earnest, lowering the water table to its present 60-80 ft below surface. The Madera area has been declared a critical overdraft area, and within both districts groundwater pollution problems have been identified. The Fresno-Madera area today has great potential for cyclic storage of groundwater, with a recharge potential of at least 1 million acre-feet. In an average year the area has greater than 400,000 acre-feet of surplus water, while in truly surplus years there are greater than 800,000 acre-feet of water leaving the area. However, there are not enough recharge facilities. Some recharge is occurring in the Fresno area, where 25,000 to 30,000 acre-feet of water are diverted into recharge and flood control basins per year. Yet, this does not offset the 70,000 to 80,000 acre-feet used by the metropolitan Fresno area. This recharge has increased the water quality of the Fresno well field. Dilution by unpolluted recharge water offers one alternative in dealing with groundwater pollution problems. Recharge potential exists in all unlined streams and ditches within the area, the only inexpensive alternative. More costly is to divert irrigation district water into flood control basins which are not used in the summer, but this requires extensive maintenance after the winter runoff. The most expensive option is the construction of new recharge basins and wells. (See also W88-09240) (Author's abstract)
W88-09247

CONSERVING WATER IN IRRIGATION,
H. Bouwer, F. S. Nakayama, R. J. Reginato, and J. A. Replogle.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 59-66, 4 fig, 22 ref.

Descriptors: *Water conservation, *Groundwater management, *Irrigation, Conservation, Irrigation efficiency, Water loss, Surface irrigation, Sprinkler irrigation, Drip irrigation, Crop yield, Evapotranspiration control, Water use, Consumptive use.

Farmers can increase the water application efficiency of irrigation systems by using more efficient gravity irrigation techniques (including laser smoothed level basins, surge irrigation, cablegation and automation). Existing inefficient irrigation methods can be converted to sprinkler or drip irrigation systems (surface or subsurface), where the uniformity of application is controlled by the system and not by the soil. Water can also be saved by growing more short season or cool season crops, or by switching to drought tolerant or salt tolerant crops. New irrigation scheduling methods using remotely sensed crop temperatures can eliminate unnecessary irrigation. Field irrigation efficiencies tend to be lower than the maximum efficiency associated with the minimum leaching requirement for achieving a salt balance in the root zone. The runoff and deep percolation water due to irrigation inefficiencies can be recycled. Thus, the efficiency of an entire irrigation project is much higher than that of individual fields. The only real consumptive water uses are evapotranspiration and water that is too saline to be used again. High field irrigation efficiencies are desirable because they reduce pumping costs and increase yields. (See also W88-09240) (Author's abstract)
W88-09248

WATER CONSERVATION IN IRRIGATION--BENEFICIAL OR NOT,
D. M. Fairchild, and R. C. Martin.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 67-76, 1 fig, 5 tab, 22 ref.

Descriptors: *Water conservation, *Groundwater management, *Irrigation, Conservation, Irrigation efficiency, Crop yield, Water reuse, Water policy, Upper Snake River Basin, Water loss, Cost-benefit analysis.

Irrigated acreage has doubled in the last 30 years and now accounts for 69% of the groundwater withdrawn in the U.S. The water requirements for energy development and the increasing population of the western states are placing greater demands on the limited water supply. Water use for irrigation has brought on availability (groundwater depletion and streamflow reduction) and quality problems (increased salinity and transport of soil, fertilizers and pesticides). Groundwater management problems have evolved in recent years to include water conservation for irrigation systems. Even though regulation of groundwater withdrawals has not been widely implemented, various water policy alternatives have been tried, including tax incentives, minimum streamflow regulations, and conjunctive management of surface and groundwater. In addition, many states have implemented water use efficiency programs and groundwater mining regulations. These programs and policies are often controversial because it is often unclear who benefits from the water savings--the farmer or society as a whole. Problems arise in implementing the programs because of inadequate legal/institutional constraints and lack of appropriate conservation incentives. For example, in many states the doctrine of prior appropriation has worked as a disincentive to water conservation practices. Consequently, this paper explores the relationship of irrigation conservation in terms of benefits and groundwater management. To determine the benefits of water conservation, it is necessary to identify the attendant individual and societal effects. Conservation practices are too often governed by local influence. The cost of irrigation improvements in efficiency as a means for augmenting water supplies may outweigh the economic benefits for many farmers. Water conservation efforts have had short-term benefits on surface water quality, but may have long-term implications for groundwater quality. In many cases, irrigation supplies will still have to be supplemented with additional water. (See also W88-09240) (Author's abstract)
W88-09249

MANAGEMENT OF GROUND WATER QUALITY BENEATH IRRIGATED ARID LANDS,
Schmidt (Kenneth D.), Fresno, CA.
K. D. Schmidt.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 77-84, 3 fig, 3 tab, 7 ref.

Descriptors: *Water quality control, *Path of pollutants, *Groundwater management, *Arid lands, *Irrigation effects, Groundwater pollution, Pesticides, Dibromochloropropane, Wells, Nitrates, Saline water, Fertilizers.

Irrigated lands in arid regions near Fresno, California, and Gilbert, Arizona, have not been managed to protect the quality of the underlying groundwater. Measurable concentrations of dibromochloropropane, a pesticide used in nematode control, were found in wells sampled in the Fresno region. It is estimated that the volume of polluted groundwater exceeds 4 million acre-feet in this area and tens of millions of acre-feet in the San Joaquin Valley. As a result, this pesticide was banned from use in 1979. In the absence of satisfactory monitoring programs at research farms, specially designed test holes for sampling groundwater at various depths and the use of deep annular seals in new production wells have proven to be highly effective. Irrigation return flow was the cause of markedly increased nitrates and salinity in wells near Gilbert, Arizona, starting in the late 1970s. Special shallow monitoring wells have been installed to study the quality of the shallow groundwater. Other management techniques for the pollutants derived from fertilizers include increased irrigation efficiency and more efficient fertilizer application. Salinity is more difficult to control, especially where low salinity surface water is unavailable for irrigation. (See also W88-09240) (Cassar-PTT)
W88-09250

MANAGEMENT PRACTICES TO REDUCE NITRATE LEACHING WITH IRRIGATED CORN,
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 5G.
W88-09251

COMPUTER CODES FOR MODELING IN CONJUNCTIVE GROUND WATER/SURFACE WATER MANAGEMENT PROGRAMS,
E. Poeter.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 104-115, 13 fig, 8 ref.

Descriptors: *Water quality management, *Water supply, *Water management, *Computer models, *Surface groundwater relations, *Groundwater management, *Model studies, *Conjunctive use, *Groundwater movement, *Computer programs, Water use, Aquifers, Numerical models, Golder Ground Water Package, GGWP code, Aquifer Flow in Porous Media codes, AFPM code, Flow in Porous Media code, FPM code, FLOCON code, MLTMSH code, Solute Transport code, SOLTR code.

Numerical models of groundwater basins are increasingly important tools in water management programs. Special features can make computer codes well-suited to water management activities. For management of layered aquifer systems, a quasi-three-dimensional modeling approach is a realistic approximation of the flow system and yields an efficient computer algorithm. A finite element formulation allows definition of a fine mesh in specific areas of interest (e.g., well fields, streams) without extending the narrow element spacing to the edge of the simulated zone. Simulation of groundwater/surface water interactions is valuable for assessment of the impacts of alternative water management schemes. This can be accomplished through calculation of the position of the phreatic surface, consideration of variable surface distributed inflow and evapotranspiration, accommodation of surface reservoirs, and simulation of streamflow across the surface of the mesh. A decoupled solute transport algorithm, which incorporates variation in the flow field as a function of time, is useful for assessment of possible salinity increases in water supplies resulting from irrigation and for assessment of contamination of water supplies from surface or underground waste disposal. A separate algorithm for simulation of two-dimensional vertical sections is useful in conceptualizing a flow system and assessing certain areas of the study region in greater vertical detail. Finally, a required feature of computer codes for water management is extensive, well-written documentation. The Golder Ground Water Package comprises six computer programs. Case studies are given as examples: increased salinity from irrigation, water management in oil shale mining, impact of evaporation ponds, and the hydrogeology of Tertiary limestones in the Mt. Gambier region of Australia. (See also W88-09240) (Cassar-PTT)
W88-09253

MANAGEMENT OF DECLINING GROUND WATER LEVELS IN PART OF EASTERN WASHINGTON,
T. M. Olson.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 129-138, 19 fig, 5 ref, append.

Descriptors: *Groundwater level, *Groundwater management, *Groundwater depletion, Hydrographs, Well hydrographs, Odessa, Washington, Model studies, Irrigation water, Permits, Model studies, Water level fluctuations, Groundwater irrigation, Water rights, Water law, Well regulations.

The Odessa Ground Water Subarea which encompasses approximately 2200 sq mi in eastern Washington, has been defined as a critical groundwater area due to the continual decline in water levels as a result of extensive groundwater withdrawals for irrigation. The use of groundwater for irrigation in the Odessa area began in the early 1960s. By 1963 the volume of groundwater withdrawn annually was 14,000 acre-feet. This withdrawal increased to 44,000 acre-feet per year beginning in 1966 and was accompanied by a marked decline in the groundwater level. In 1967, a moratorium became effective on all pending applications for new water rights in the area, so that a study could be made to determine the long-term effects on the resource of large-scale groundwater withdrawals. In conjunction with the moratorium, the Department of Ecology, in cooperation with the U.S. Geological Survey, began development of data for use in a digital computer model of the Odessa groundwater system. Additionally, cooperative programs with Washington State University Agricultural Engineering Department were initiated to evaluate use of flow meters and evaluate economic effects of a declining water table on farming practices. By 1973, groundwater withdrawals from the Odessa area had reached 117,000 acre-feet per year, and the state of Washington declared it to be a critical groundwater area. Thereafter, using the results of an economic study of the cost/benefit ratio of pumping groundwater in the Odessa area, groundwater management regulations were enacted by the state. These regulations contemplate a controlled maximum rate of 30 ft in three years for lowering of the groundwater level down to a maximum depth of 700 ft below land surface. The computer model is used in issuing new rights to water so that these rights to water do not result in a faster than planned year-to-year decline in the groundwater levels, and the approach to the maximum pumping depth of 700 ft below land surface can be predicted with reasonable certainty. Amendments of 1982 to the management regulations include a unique concept in Western water law referred to as acreage expansion under which a quantity of water historically used on a specific parcel of land may be expanded and used on a greater acreage at a lesser water duty per acre. (See also W88-09240) (Author's abstract)
W88-09255

INTERGOVERNMENTAL MANAGEMENT STRATEGY FOR THE PROTECTION OF A CONJUNCTIVE USE RESOURCE,
Lane County Government, Eugene, OR.
For primary bibliographic entry see Field 5G.
W88-09256

GROUND WATER MANAGEMENT STRATEGIES FOR ARIZONA,
Arizona Dept. of Water Resources, Phoenix.
P. C. Briggs.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 149-154.

Descriptors: *Groundwater management, *Arizona, *Water law, *Groundwater depletion, Subsidence, Management planning, Water rights, Permits, Wells, Water quality, Groundwater pollution, Water conservation, Irrigation efficiency.

The Arizona Ground Water Management Act of 1980 established a system of groundwater rights for existing groundwater users and a permit system for new users. The act also requires that a series of management plans be prepared to direct the use of groundwater and specifies that the areas be brought from the current condition of overdraft to one of safe yield within 45 years. Other problems that must be addressed include land surface subsidence in response to aquifer dewatering, naturally occurring poor water quality zones that limit uses of the groundwater and polluted areas that require remedial action or containment. For the next 20 years the act prescribes that all right holders will be subjected to ever increasing conservation requirements which will aid in reducing overdraft, but it provides limited management opportunities to respond to the other problems. Additionally, the act provides only limited direction as to how permit holders will be regulated or how new permits and new demands for groundwater can be accommodated and still meet the overall goal of safe yield. In response to this situation, the Arizona Department of Water Resources is developing management strategies that utilize existing authorities, such as well spacing and construction standards, as well as withdrawal policies for new permits to be incorporated in the management plans. The withdrawal policies could take one of two approaches; either a basinwide set of criteria (such as limiting rates of decline or poor quality only) would be established or a set of criteria would be used to delineate withdrawal zones (as closed to further withdrawals or open for poor quality withdrawals) that could cover a subbasin or a vertical or horizontal portion of an aquifer. At this time the management plans are in draft form; whether any or all of the strategies survive the public review process is unknown, but it is clear that the problems facing Arizona are complex and that their solution will require new approaches to groundwater management. (See also W88-09240) (Author's abstract)
W88-09257

CHANGING SCENE OF GROUND WATER MANAGEMENT IN IDAHO,
Idaho Univ., Moscow.
D. R. Ralston.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 155-158, 3 fig, 4 ref.

Descriptors: *Water rights, *Groundwater management, *Groundwater mining, *Idaho, Appropriation, Snake River Basin, Groundwater depletion, Swan Falls, Dam, Recharge.

Groundwater management in Idaho is in a period of change. Conflicts between surface water and groundwater use are increasing; groundwater mining is occurring in some areas. Surface water and groundwater are administered in Idaho under the appropriation doctrine. The Idaho Code specifies that: (1) prior surface water and groundwater rights must be considered in allowing new or continued groundwater appropriation, and (2) groundwater mining is not allowed. Idaho ranks in the top five in the nation in the pumpage of groundwater, primarily in the arid southern portion of the state. The Snake River Basin, which includes most of the pumpage in southern Idaho, has not been managed historically as a conjunctive surface water-groundwater system. The surface water resources are essentially fully appropriated. These resources are managed by means of a number of water districts with boundaries based upon surface water features. The water districts overlie a regional groundwater resource. A number of Critical Ground Water Areas have been designated in southern Idaho. These designations have been based upon major declines in groundwater levels. None of these areas has been closed because of interference with downstream senior surface water or groundwater users. A recent court decision on the required flows for a hydroelectric dam on the Snake River raised serious questions with respect to existing and future uses of groundwater in southern Idaho. This controversy underscores the need to understand and classify the groundwater resources in this portion of the state. Future groundwater management in Idaho must recognize the mining aspects of some basins and the nature and timing of groundwater related impacts on surface water system. Changes in the Idaho Code will be necessary to reflect the different classifications of groundwater systems. (See also W88-09240) (Author's abstract)
W88-09258

GROUND WATER MANAGEMENT: SAN DIEGO STYLE,
San Diego County, CA.
J. E. Peterson.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 160-165, 1 tab.

Descriptors: *Groundwater management, *Geohydrology, *Nonstructural alternatives, *San Diego,

*California, Water level, Water policy, Monitoring, Zoning, Water zoning, Land use.

San Diego County, California, is an extremely variable hydrologic area of 4314 sq mi with rainfall varying between 3 and 39 inches per year. The 1980 population of 1,860,000 is expected to grow to 2,688,000 by the year 2000. The majority of the population live in the western coastal zone and utilize imported water. Approximately 22,000 residents live in the central and eastern portions of the county and rely on groundwater. These areas have a high growth rate and are underlain by a fractured rock aquifer with limited storage capacity. This has produced a need for a well developed plan of groundwater management. San Diego County has enacted a groundwater policy which stipulates minimum lot sizes dependent upon average annual rainfall. These lot sizes vary between 2 and 20 acres. This allows development without requiring site-specific investigations. If a proposed development exceeds the allowable density, a site-specific groundwater investigation could be completed to prove adequate water resources. The policy regulates all residential and commercial development; however, no controls on agricultural activities are included. The county has established a groundwater monitoring program to evaluate the density controls. The program has shown that residential development has not adversely affected groundwater levels but that agricultural development has produced local and sometimes extreme mining conditions. One valley has experienced water level declines in excess of 250 ft within a six-month period. This has resulted in a number of domestic wells going dry. To validate the density controls in the groundwater policy, the county has begun a cooperative groundwater research investigation into groundwater recharge, flow and storage within fractured rock reservoirs. This investigation is a joint effort between the United States Geological Survey, local consulting firms and the county of San Diego. (See also W88-09240) (Author's abstract)
W88-09259

GROUND WATER MANAGEMENT IN OWENS VALLEY, CALIFORNIA,
Los Angeles City Dept. of Water and Power, CA.
W. E. Kruse.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 166-173, 3 fig, 6 ref.

Descriptors: *Groundwater management, *Water supply, *Owens Valley, *California, Water use, Los Angeles, Owens River, Mono Basin, Aqueducts, Diversion, Drought.

The Owens Valley Ground Water Basin supplies significant amounts of water to Los Angeles, especially in years of below normal surface water runoff. The Los Angeles aqueduct system receives water from the Owens River and Mono Basin watersheds. The First Los Angeles Aqueduct (FLAA) was placed in service in 1913; and the Second Los Angeles Aqueduct (SLAA), in 1970. Water for the SLAA is obtained from increased surface water diversions in Owens Valley and Mono Basin and increased Owens Valley groundwater pumping. (Groundwater for the FLAA was pumped only during severe drought periods, mainly in the 1920s and 1930s and the early 1960s). The FLAA and SLAA were designed to deliver an average annual supply of 482,000 acre-feet per year to Los Angeles. Total use is about 564,000 acre-feet per year. An average of 112,000 acre-feet per year of groundwater pumping is necessary to supplement surface water during years of insufficient runoff to supply the aqueducts and in-valley uses. About 452,000 acre-feet per year is obtained from surface water diversion. Los Angeles also spreads water by percolation in channels and on alluvial fans during wet years. Surface water diversion activities, applications of water to the land, and groundwater pumping have caused changes to occur in Owens Valley. Inyo County is concerned that increased groundwater extraction for the SLAA during droughts will cause adverse impacts, i.e., vegetation loss and dust. Inyo County is attempting to obtain control of all local groundwater extractions by implementing a groundwater pumping ordinance, to which Los Angeles objects. The Los Angeles Department of Water and Power and Inyo are attempting to resolve different management objectives based on a differing understanding of geohydrology and environmental systems. They have joined together with the U.S. Geological Survey to develop a management model for the Owens Valley Ground Water Basin. (See also W88-09240) (Cassar-PTT)
W88-09260

GROUND-SURFACE WATER TECHNICAL AND QUASI-LEGAL RELATIONSHIPS,
Tipton and Kalmach, Inc., Denver, CO.
For primary bibliographic entry see Field 2A.
W88-09261

GROUND WATER RIGHTS IN CALIFORNIA,
For primary bibliographic entry see Field 6E.
W88-09262

FORGING THE NEW WATER LAW: PUBLIC REGULATION OF PROPRIETARY GROUND WATER RIGHTS,
McCutcheon, Doyle, Brown and Enersen, San Francisco, CA.
For primary bibliographic entry see Field 6E.
W88-09264

GROUND WATER QUALITY MANAGEMENT IN ARIZONA,
For primary bibliographic entry see Field 5G.
W88-09266

CLATSOP PLAINS, OREGON: DUNAL AQUIFER EVALUATION AND GROUND WATER PROTECTION PLAN,
Sweet, Edwards and Associates, Inc., Kelso, WA.
For primary bibliographic entry see Field 5G.
W88-09268

INFLUENCE OF VERTICAL VARIATIONS IN LITHOLOGY ON A MATHEMATICAL MANAGEMENT MODEL FOR THE OGALLALA AQUIFER, TEXAS COUNTY, OKLAHOMA,
W. W. Loo.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 268-277, 11 fig, 2 tab, 24 ref.

Descriptors: *Mathematical models, *Groundwater management, *Model studies, Ogallala Aquifer, Geohydrology, Aquifers, Oklahoma, Groundwater depletion, Wells, Vertical distribution.

A groundwater management model for the Ogallala aquifer in the Texas panhandle was modified for the Ogallala Auifer in the Oklahoma panhandle by treating the aquifer as a multilayered system with vertical variations in lithology. Application of the model to both homogeneous and multilayered cases showed a 60-ft difference between the cumulative drawdown values for these two aquifer types at the time the base of the aquifer was encountered. These vertical variations should be considered in making predictions of groundwater management in the Oklahoma aquifer. (See also W88-09240) (Cassar-PTT)
W88-09270

USE OF A COMPUTER MODEL FOR GROUND WATER MANAGEMENT, EASTERN SAN JOAQUIN COUNTY, CALIFORNIA,
Brown and Caldwell, Sacramento, CA.
J. E. Salo, and J. T. Schick.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 278-285, 5 fig, 1 tab, 2 ref.

Descriptors: *Computer models, *Groundwater management, *Model studies, San Joaquin County, California, Geohydrology, Groundwater depletion, Aquifers, Saline water.

A groundwater flow model based on the Prickett-Longquist code is being evaluated as a tool in groundwater management in the eastern San Joaquin County basin, California. A one-square-mile nodal network is being applied. The groundwater basin is being modeled as a two-layer case with an upper unconfined layer and a lower confined layer. The calculated water levels for the predictive runs will be used to project the future movement of saline groundwater from the delta. The water levels will also be used to calculate change in cost due to increase or decrease in pumping level. Capital, operation and maintenance costs for conveyance and distribution facilities under three alternative modes of development and use will be determined. (See also W88-09240) (Cassar-PTT)
W88-09271

INCORPORATION OF PREDICTED FUTURE CLIMATIC EFFECTS INTO SIMULATIONS FOR GROUND WATER RESOURCE EVALUATIONS,
For primary bibliographic entry see Field 2A.
W88-09272

USING COMPUTER METHODS IN ISLAND WATER RESOURCE MANAGEMENT, VASHON/MAURY ISLAND, WASHINGTON,
R. W. Ritzi, R. G. Schmidt, and J. R. Carr.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 304-312, 13 fig, 1 tab, 5 ref.

Descriptors: *Resources management, *Washington, *Groundwater management, *Model studies, *Islands, *Data processing, Mapping, Computer models, Vashon Island, Maury Island, Aquifers.

Methods for storing, processing and displaying geologic and hydrologic data utilizing computer were used extensively in preparing background material for a water management plan for Vashon/Maury Island, Washington. The plan is seen as a requisite step in preparing companion plans for population growth and land use management purposes. Because islands are uniquely fragile environments and suffer unusual developmental pressures, the need for rational water resources management on islands has reached critical dimensions in many areas. Use of existing, readily available methods for storing, manipulating and displaying inventory data has many advantages to the water planner and manager. Among these are (1) ease of data editing, including correction, additions, and deletions; (2) rapid, simple modification or updating of display graphics; (3) elimination of tedious and error-prone duplicative clerical tasks; and (4) potential for testing many more hypothetical ideas than would be practical by manual methods. For Vashon/Maury Island, conventional geologic and hydrologic data were complied for entry and processing by several methods. A computer contouring program STAMPEDE/IBM was used to calculate and display structural configuration of aquifers and their bounding layers for water table surfaces, stratigraphic data, water quality data and similar manipulations. In addition, this and other related information was used in developing recharge potential maps using multiple programs to perform manipulation and graphic display functions. Although the use of machine processing methods has great advantages, the fact that data spacing on the islands was not uniform in density caused some problems. Both judgmental and aesthetic alterations to maps were required. (See also W88-09240) (Author's abstract)
W88-09274

WATER RESOURCE MANAGEMENT PLANNING CRITERIA FOR VASHON/MAURY ISLAND, WASHINGTON; A CASE STUDY,
J. R. Carr, R. G. Schmidt, and R. W. Ritzi.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 317-325, 12 fig, 15 ref.

Descriptors: *Groundwater management, *Resources management, *Islands, Data processing, Management planning, Mapping, Computer models, Vashon Island, Maury Island, Washington, Water quality, Recharge, Groundwater recharge, Precipitation, Water supply, Land use, Model studies, Case studies.

The glacially derived sediments of Vashon/Maury Island, Washington, are recharged only by direct precipitation. On an islandwide basis, recharge is equivalent to about 5 inches per year, or 9 mgpd. The amount of suitable quality groundwater that could be recovered on a sustained basis is estimated to be 1.3 mgpd. This amount of water would support the existing population of 8000 plus and additional 3000 people. Protection of the water supplies of the island from overdevelopment can best be accomplished by active management where continuing input of hydrologic data is used as the basis for regulation. Without active management, the regulations on land use applied through passive management (without monitoring) would be even more restrictive. (See also W88-09240) (Author's abstract)
W88-09275

GROUND WATER SAFE YIELD USING LOW-FLOW FREQUENCY ANALYSIS,
Boyle Engineering Corp., San Diego, CA.
K. A. Popko, and Y. S. Yoon.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 340-342, 2 fig, 2 ref.

Descriptors: *Safe yield, *Low flow, *Groundwater management, *Water supply, *Frequency analysis, *Recharge, Groundwater recharge, Drought, Water table fluctuation, Water storage, San Diego County, California.

A low-flow frequency analysis method was combined with a mass curve technique to estimate annual pumpage that would not result in excessive water level declines during a 100-year drought in a rural San Diego County water district. A graphical analysis method was applied to determine the amount of recharge that would be expected during droughts with various return periods and durations. The next step was to estimate water table declines that would occur during selected droughts if long-term average annual recharge were completely consumed. The safe yield estimated by this method was about 50% less than long-term average annual recharge derived from 75 years of precipitation records. (See also W88-09240) (Cassar-PTT)
W88-09277

DATA BASE MANAGEMENT SYSTEM APPROACH TO GROUND WATER MANAGEMENT,
G. L. Hix.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 351-355, 3 fig, 17 ref.

Descriptors: *Data storage and retrieval, *Groundwater management, *Data acquisition, *Data collections, Monitoring, Computers, Data processing, Information retrieval, Automation.

Suggestions are given for designing and implementing a data base management system for groundwater monitoring programs. Several references on methods for collecting and managing groundwater monitoring data are given. The program should consider the information needs, which vary according to the type of organization: private water company, public utility, mine, or general industry. Factors to consider are the nature of the data being collected (format, complexity, accuracy, volume, and periodicity) and the form of output (direct output for immediate use, storage in paper files for later utilization, multiple copies, direct storage in the data base). In the conceptual design of a groundwater data base management system, the major categories of data collection are quantity, quality, production, and protection. The data base may contain short-term files, operational files, and permanent files. Output may be internal (forms, reports, permanent records, visual displays) and external (tabulations, summaries, charts, graphs, maps). (See also W88-09240) (Cassar-PTT)
W88-09279

RECOMMENDED REVISIONS FOR SAN DIEGO COUNTY'S RURAL GROUND WATER POLICY AND GROUND WATER INVESTIGATION PRACTICES,
L. Hamdan.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 362-366, 1 tab, 1 ref.

Descriptors: *Regulations, *Rural areas, *Groundwater management, *Water policy, *San Diego County, *California, Recharge.

The present groundwater policy in the rural eastern two-thirds of San Diego County, California, empowers the county to refuse to issue land development permits for projects requiring more water than the estimated available supply on the project's site. This policy has three main shortcomings: (1) It contains no provisions or stipulations to limit or monitor groundwater extractions by the landowners; (2) Although the methodologies used to evaluate estimates of the recharge rate and groundwater in storage are justified, the accuracy of computed estimates has not been verified; and (3) A project's share of a watershed groundwater supply is commonly evaluated by prorating the project site area to the total area of the watershed. Several recommendations are made. (1) Impose limits on all groundwater extractions so that the total extractions do not exceed the total available supply. (2) Verify estimates of recharge rates and groundwater in storage. (3) Revise procedures for evaluating a project's share of watershed supply. (See also W88-09240) (Cassar-PTT)
W88-09281

SPACING OF WELLS IN ARIZONA,
G. Wickersham.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 367-369, 1 fig, 1 tab.

Descriptors: *Well regulations, *Water supply development, *Groundwater management, *Arizona, Wells, Regulations.

Arizona established a well spacing regulation that uses a drawdown limit to define interference between wells. The policy states that the impact from a new well cannot exceed 25 feet of additional drawdown over a five-year period. A drawdown greater than 25 feet would constitute unreasonably increasing damage and the well application rejected. New wells with less than 10 feet of additional drawdown are accepted. For proposed wells with a projected impact on an existing well of 10-25 ft of additional drawdown, as series of factors are considered by the department in making a well spacing determination. (See also W88-09240) (Cassar-PTT)
W88-09282

PROCEEDINGS OF THE FOURTH ANNUAL EASTERN REGIONAL GROUND WATER CONFERENCE.
Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. 783 p.

Descriptors: *Groundwater management, *Groundwater pollution, *Leaching, *Storage tanks, *Groundwater movement, Water pollution sources, Path of pollutants, Pesticides, Agricultural runoff, Soil contamination, Geohydrology, Aquifers, Remote sensing, Hazardous wastes, Monitoring.

The Fourth Annual Eastern Regional Ground Water Conference was held in Burlington, Vermont, on July 14-16, 1987. The conference covered several topics including: local, state, and federal groundwater management strategies; the management, investigation and remediation of leaking underground storage tanks; domestic sewage impacts on groundwater, the assessment and management of pesticide impacts on groundwater, characterization of groundwater flow and contaminant transport; investigative techniques in groundwater; and aquifer restoration and remedial action. Government officials, hydrogeologists, consulting engineers, geologists, researchers, industry representatives and other interested persons met to learn and discuss pertinent issues and state-of- the-art techniques employed in groundwater studies. The conference provided a forum for all who attended to communicate and share their experiences in the rapidly developing industry. These proceedings are a compilation of papers presented by the conference speakers. (See W88-09478 thur W88-09520) (Author's abstract)
W88-09477

WELLHEAD PROTECTION IN EASTERN STATES: PROGRAM BASES AND PROSPECTS,
Dames and Moore, Bethesda, MD.
R. F. Ehrhardt, and M. C. McMillen.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 3-11, 12 ref.

Descriptors: *Groundwater pollution, *Groundwater management, *Wells, *Eastern United States, *Water quality management, *Water pollution prevention, Water pollution control, Well seepage, Public participation, Water pollution sources.

The Safe Drinking Water Act Amendments of 1986 authorize the U.S. Environmental Protection Agency (EPA) to fund state programs for wellhead protection. According to the statute, state programs should include seven elements: (1) identification of agency duties, (2) delineation of wellhead protection areas, (3) identification of anthropogenic sources of contaminants, (4) management and control measures, (5) contingency plans, (6) protection of new wells, and (7) public participation. The intent of Congress in formulating the statute, was to give states considerable flexibility as to how these elements will be addressed in individual state wellhead protection programs. To the extent possible, if only for practicality and efficiency, many states are likely to build on existing groundwater quality protection programs in developing their strategies for wellhead protection. The kind of wellhead protection program a state decides to employ, if any, may be as much a function of its existing groundwater program, as any other factor such as level of available funding or details of EPA's wellhead protection program guidance. (See also W88-09477) (Author's abstract)
W88-09478

GROUNDWATER MANAGEMENT ISSUES IN THE ATLANTIC PROVINCES,
Environmental Protection Service, Dartmouth (Nova Scotia).
F. B. Cruickshanks, J. E. Gibb, and T. W. Hennigar.
IN: Proceedings of the Fourth Annual Eastern Regional Groundwater Conference. Burlington,

Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 45-54, 14 ref.

Descriptors: *Groundwater management, *Canada, *Management planning, *Groundwater pollution, *Groundwater potential, Water resources development, Future planning, Saline water intrusion, Pesticides, Path of pollutants, Research priorities.

Although groundwater is an important resource in Atlantic Canada, there remains a large gap in knowledge concerning groundwater resources. Less than half of the region has been surveyed with respect to its hydrogeological characteristics and groundwater potential. Research into toxic chemicals, particularly pesticide dynamics, exploration techniques, and others will need to continue. Research priorities should focus on more strategic planning in areas where groundwater is a constraining factor or provides an opportunity for economic development. The elements of strategic planning include a better understanding of current groundwater usage, definition of future water requirements, identifying areas where groundwater may constrain development, identifying groundwater resource potentials, identifying areas where contamination is or could be a problem, and conducting research to solve particular problems. (See also W88-09477) (Geiger-PTT)
W88-09480

MANAGING GROUND WATER IN MAINE: THREE APPROACHES,
Gerber (Robert G.), Freeport, ME.
A. L. Tolman, and W. R. Holland.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 55-63, 7 ref.

Descriptors: *Groundwater management, *Maine, *Hydrologic maps, *Aquifer characteristics, *Aquifer management, Mapping, Sand aquifers, Management planning, Water pollution prevention, Wells, Water quality control, Groundwater pollution, Water pollution control.

The State of Maine is fortunate to have avoided some of the more serious problems resulting from development which have plagued its southern neighbors. In an effort to continue this good fortune, the State and some municipalities have used several strategies to manage development to reduce its effect on groundwater. Three of the strategies which have been used are regional aquifer mapping, technical review of development applications, and definition and protection of source areas for public water supplies. The state has been actively involved in aquifer mapping since 1987, and has almost completed the second approximation of the sand and gravel aquifers. These maps have been used and misused by government, consultants, and citizens to limit development on areas overlying aquifers. More recently, the State and certain towns have also contracted with consultants, including Robert G. Gerber, Inc., to provide assistance in planning board review of proposed developments which may have an impact on groundwater. Some towns and water districts have also retained Robert G. Gerber, Inc., and other consultants to estimate contributing areas and travel times for their groundwater supplies. Both these latter activities often use aquifer mapping as a starting point, and both ideally result in reduced density or intensity of use in sensitive areas. All three of these approaches have had some success, but none seems to solve all the problems, and even the combination of the three may not preclude inappropriate development. Regional aquifer mapping, source area definition, and application review need to be parts of an overall effort to be successful. With Maine's independent spirit and commitment to local control, such coordination is not readily accomplished. (See also W88-09477) (Author's abstract)
W88-09481

STATE GROUND WATER DATA MANAGEMENT,
Sewall (James W.) Co., Old Town, ME.
M. A. Jadkowski, and P. W. Dutram.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 65-79, 3 tab.

Descriptors: *Groundwater management, *Data storage and retrieval, *Maine, *Data acquisition, Networks, Computer programs, Management planning, Hydrologic data collections.

Twenty-five state and federal programs generate groundwater information in Maine. Most data are filed manually. A number of computerized data management systems are also used to manage groundwater related information. These vary in capability from simple data storage and retrieval to sophisticated database management system and geographic information system functions. Most data filing requirements and data management systems are designed to meet the specific needs of individual agencies. Statewide, however, groundwater information can be most useful when it is mutually accessible by all of the generators and/or users. Current data management practices in Maine do not provide this accessibility. Maine's Land and Water Resources Council has recently completed a study to (1) evaluate how existing data management systems are currently being used to support State efforts to manage Maine's groundwater, and (2) identify what new arrangements will be needed to implement any further management programs now under consideration. Currently the Council is directing a follow-up project with the development of specific database management system options as its primary goal. This paper describes Maine's progress in development of a mutually accessible groundwater data management system. Consideration is given to (1) groundwater programs and the types of data that result from them; (2) current forms of groundwater data management; (3) the need for computerized data management; (4) accessibility, communication, and security of data; (5) desirable data management functions and features; (6) overall system design; and (7) selection criterion for commercial systems and database implementation. (See also W88-09477) (Author's abstract)
W88-09482

UPPER NEPONSET VALLEY AQUIFER STUDY: INTEGRATING GROUND WATER QUALITY PROTECTION WITH CONTAMINATION INVESTIGATIONS,
Massachusetts Dept. of Environmental Quality Engineering, Boston.
For primary bibliographic entry see Field 5G.
W88-09483

FLORIDA - PROVIDING INCENTIVE FOR REPORTING LEAKS,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5G.
W88-09484

FEDERAL CORRECTIVE ACTION REQUIREMENTS FOR PETROLEUM UNDERGROUND STORAGE TANKS,
ICF, Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W88-09485

CASE STUDY OF A LARGE SCALE PRECISION TANK TESTING PROGRAM,
Tetra Tech Richardson, Newark, DE.
For primary bibliographic entry see Field 5G.
W88-09486

DESIGN CONSIDERATIONS FOR UNDERGROUND STORAGE TANK INSTALLATIONS REQUIRING SECONDARY CONTAINMENT: A CASE STUDY,
Benatec Associates, Inc., Harrisburg, PA.
For primary bibliographic entry see Field 5G.
W88-09487

IN-SITU ANALYSIS OF GASOLINE-CONTAMINATED GROUND WATER,
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W88-09489

IS PRIVATE WELL PROTECTION ADEQUATE WHEN GROUND WATER FLOW IS IGNORED,
K-V Associates, Inc., Falmouth, MA.
For primary bibliographic entry see Field 5G.
W88-09495

REGIONAL OPTIONS FOR GROUND WATER QUALITY MANAGEMENT IN RELATION TO AGRICULTURAL ACTIVITIES,
Maryland Univ., College Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W88-09496

HYDROGEOLOGIC INVESTIGATION OF WILLIAMSBURG, MASSACHUSETTS. SESSION: GLACIAL GEOLOGY/HARD ROCK,
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 2F.
W88-09503

REDEVELOPMENT OF CLOGGED RECHARGE WELLS,
Kuwait Fund for Arab Economic Development, Safat.
A. F. Bichara.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 343-350, May 1988. 4 fig, 1 tab, 2 ref.

Descriptors: *Well development, *Wells, *Recharge wells, *Clogging, *Model studies, Redevelopment techniques, Pumping, Artificial recharge, Backwash, Aquifers.

Field conditions were reproduced in the laboratory in order to investigate redevelopment techniques. Segmental perspex models were recharged with water of controlled quality and temperature containing different types of suspended solids of known size. Both gravel- and nongravel-packed recharge wells were tested. It was found that the most efficient method of redeveloping a clogged recharge well was by multiple reversals of flow direction (i.e., pumping and recharging the aquifer). A purely intermittent pumping action following the first reversal of flow had practically no increased beneficial effect on the recovery recharge rates. It was also concluded that neither increasing the driving head under which the reversal is carried out nor increasing the duration of the reversal of flow has a marked beneficial effect. Nongravel-packed wells were easier to redevelop than gravel-packed ones and the use of backwashing tubes in the gravel pack did not prove highly successful in restoring the well efficiency. (Author's abstract)
W88-09744

INTERPRETING INJECTION WELL TESTS IN AN ALLUVIAL AQUIFER,
Birmingham Univ. (England). Dept. of Civil Engineering.
K. R. Ruston, and N. K. Srivastava.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 49-60, May 1988. 9 fig, 1 tab, 6 ref.

Descriptors: *Alluvial aquifers, *Clogging, *Injection wells, *Artificial recharge, *Model studies, *Aquifers, Field tests, Hydraulic conductivity, Permeability coefficient, Soil properties, Hydrology, Geohydrology, Mathematical studies, Equations.

Artificial recharge using injection wells can present practical difficulties and it is important to be able to identify and quantify the features which cause these difficulties. This paper describes the analysis, using a mathematical model, of field information which was obtained from an injection test

in an alluvial aquifer; the test continued for 250 days. Aquifer parameters were estimated both for the more permeable sand layers and the less permeable clay layers. During the test severe clogging occurred in the vicinity of the well and the mathematical model was also used to quantify the reduction in hydraulic conductivity due to the clogging. (Author's abstract)
W88-09914

EXPERIMENTAL STUDIES IN STREAM-AQUIFER INTERACTION ALONG THE ARKANSAS RIVER IN CENTRAL KANSAS: FIELD TESTING AND ANALYSIS,
Kansas State Geological Survey, Lawrence.
M. Sophocleous, M. A. Townsend, L. D. Vogler, T. J. McClain, and E. T. Marks.
Journal of Hydrology JHYDA7, Vol. 98, No. 3/4, p 249-273, April 15, 1988. 24 fig, 2 tab, 20 ref.

Descriptors: *Groundwater movement, *Aquifers, *Drawdown, *Recharge, *Streamflow, *Surface-groundwater relations, *Streamflow depletion, *Aquifer characteristics, *Mathematical Analysis, *Confined Aquifers, Leaky Arkansas River, Aquifers, Observation Wells, Kansas, Pumping tests. Aquifers, Depletion.

During the last several years, streamflows of a number of Kansas streams have been reduced as a result of groundwater declines. In order to better understand and quantify stream-aquifer interrelationships, an eight-day comprehensive stream-aquifer pumping test, followed by recovery monitoring, was conducted along the Arkansas River near Great Bend, Kansas. In addition to water level monitoring in numerous observation wells, streamflow data, streambed hydraulic gradients, neutron-probe based water content of dewatered sediments, water chemistry, and other data were collected. The alluvial aquifer is shown to be highly transmissive (T = 1803 sq m/d) with the pumping stress (9538 cu m/d) having a radius of influence larger than 1.77 km, impacting both the aquifer levels and the streamflow in the nearby Arkansas River. Drawdown and recharge boundary effects were observed in all observation wells, including those on the opposite side of the river. The alluvial aquifer did not exhibit a water table behavior and responded as a leaky confined aquifer. A semiconfining clay layer less than 3 cm thick and an additional recharge source from a nearby stream-alluvial system were the probable cause of the observed phenomena. Actual streamflow depletion is shown to be appreciably less than the computed depletion based on analytical solutions. (Author's abstract)
W88-09976

ANALYSIS OF HISTORICAL AND CURRENT DRAWDOWN AND PRODUCTION DATA FROM THE BOISE GEOTHERMAL SYSTEM,
Boise State Univ., ID. Dept. of Geology and Geophysics.
C. J. Waag, and S. H. Wood.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164280/AS. Price codes: A04 in paper copy; A01 in microfiche. Idaho Water Resources Research Institute, Moscow, Completion Report, August 1987. 47 p, 7 fig, 5 tab, 22 ref.

Descriptors: *Aquifer systems, *Geothermal aquifer systems, *Drawdown, *Geothermal resources, *Selective withdrawal, Idaho, Boise Geothermal Aquifer System, Potentiometric levels, Artificial recharge.

Since 1982 withdrawals from the Boise Geothermal aquifer system have increased from < 300 million to > 600 million gals/yr. Prior to 1983 the system appears to have been in or near equilibrium. Current production levels exceed the ability of the system to recover on an annual basis. Potentiometric levels within the aquifer are declining at increasing rates and a new equilibrium level is not evident. Thus, exploitation of the geothermal aquifer is currently outstripping knowledge and understanding of the aquifer. It is time to give serious consideration to placing a temporary moratorium on further development and production from the system until a better understanding of its capacity is achieved. Serious consideration should also be given to requiring reinjection of produced waters where feasible. Although no data base exists to predict accurately the effects of reinjection, current interpretation of the aquifer system and the apparent degree of inter-connection that exists within it suggests that reinjection will significantly affect the economic productivity and extend the life of the resource. Expressed concerns for temperature declines within the system caused by reinjection are recognized and may be legitimate. However, the rather small difference between production and rejection temperatures in one area of the system is encouraging, and other producers should strive to design reinjection systems that would achieve similar or superior results. (USGS)
W88-10011

GEOCHEMICAL ASSESSMENT OF AQUIFER RECHARGE EFFECTS IN THE SOUTHWEST DENVER BASIN,
Colorado School of Mines, Golden. Dept. of Geology.
A. R. Aikin, and A. K. Turner.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-186069. Price codes: A04 in paper copy; A01 in microfiche. Colorado Water Resources Research Institute, Ft. Collins, Completion report No. 146, September 1987. 45 p, 10 fig, 5 tab, 32 ref. Contract No. 14-08-0001-G1006 and 14-08-0001-G1214. Project No. USGS G1006-03 and G1214-03.

Descriptors: *Denver, *Injection recharge, *Groundwater recharge, *Geochemistry, Recharge wells, Colorado, Computer models, Arapahoe aquifer, Drinking water, Water supply, Municipal water.

Recharge of the Denver groundwater basin by injection has been proposed as a result of increasing depletion of the water supply. However, injection recharge can cause physical and chemical changes in the geologic materials of the recharged aquifer, depending on the chemistry of both the host and injected waters as well as the mineralogy of the aquifer's rock matrix. The Denver groundwater basin contains four principal bedrock aquifers, of which the Arapahoe aquifer is considered to be the best in terms of water quality and quantity. Some preliminary field injection tests have been undertaken using drinking water supplies. However, water that meets drinking water standards contains constituents which may react upon injection, resulting in aquifer damage. The field injection tests have demonstrated that permeability apparently decreases after a few hours, but the cause was not known. As a preliminary step in designing future field tests, analyses of aquifer water and Denver Water Board municipal drinking water were evaluated by a geochemical equilibrium computer model (PHREEQE), developed by the U.S. Geological Survey, to determine the potential for reaction. The results of these simulations confirm that the Arapahoe aquifer is a good candidate for injection recharge. No fatal flaw appears to exist, from a geochemical standpoint, which would prevent the use of drinking water to recharge the Arapahoe aquifer. (USGS)
W88-10028

RECHARGE AS AUGMENTATION IN THE SOUTH PLATTE BASIN,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
J. W. Warner, D. Sunada, and A. Hartwell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-180435/AS. Price codes: A08 in paper copy; A01 in microfiche. Colorado Water Resources Research Institute, Fort Collins, Completion Report No. 144, September 1987. 116 p, 10 fig, 10 tab, 12 ref, 3 append. Contract No. 14-08-0001-G1006. Project No. USGS G1006-22.

Descriptors: *Artificial recharge, *Return flow, *Groundwater recharge, *Surface-groundwater conjunctive management, *Augmentation plan, Basinwide water management, Colorado, South Platte River Basin.

Artificial recharge is a newly emerging technology for water management in the South Platte River Basin of Colorado. Currently there are about 44 recharge sites being operated, mostly for the purpose of augmenting streamflows. Augmentation is needed to offset the stream depletion caused by pumping from the alluvial aquifer in contact with the river. These augmentation/recharge projects have evolved from the quest for better basinwide water management in order to optimize the use of a limited water supply. Pilot recharge projects were first tried in the early 1960s. Some of them were recharge demonstrations and some were research sites. They are summarized in the report with brief descriptions of each project. These pilot projects proved the feasibility of artificial recharge in the South Platte Basin. More recently water supply organizations have begun to operate augmentation/recharge projects, often taking advantage of seepage from existing facilities such as canals and reservoirs. The report documents physical characteristics, water supplies and operating plans for existing recharge sites. The role of each site in an augmentation plan is described. The purpose of most of the artificial recharge sites is to produce return flow to the river for augmentation of river flow. The analytical methods currently being used to calculate the timing and amount of return flow from a recharge site were evaluated. The two most popular methods are: (1) the Glover method; and (2) the Stream Depletion Factor method (based on the Glover method). Example applications of each method are given and compared. The current laws and administrative rules which govern augmentation/recharge in the South Platte Basin are summarized. A typical plan for augmentation is documented in complete detail including the court decree (Fort Morgan Reservoir and Irrigation Company). (USGS)
W88-10034

LARGE SCALE PARAMETER ESTIMATION THROUGH THE INVERSE PROCEDURE AND UNCERTAINTY PROPAGATION IN THE COLUMBUS BASIN, NEW MEXICO,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
T. N. Blandford, and J. L. Wilson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-155932/AS. Price codes: A12 in paper copy; A01 in microfiche. New Mexico Water Resources Research Inst., Las Cruces, Technical Completion Rpt. 226, Sept. 1987. 247p, 101fig, 11tab, 44ref, append. Contract 14-08-0001-G922(3) and 14-08-0001-G1033-03). Proj. USGS G1033-03; State Proj, 1423535 and 1423652.

Descriptors: *Groundwater, *Parameter estimation, *Inverse problem, *Risks, *Aquifer characteristics, Management, Finite element analysis, New Mexico, Columbus Basin, Model studies.

Estimates of the aquifer parameters storativity, transmissivity, boundary heads and fluxes were made for the Columbus Basin, New Mexico. A two-dimensional groundwater flow code caller CERT was used. An initial or prior estimate of the aquifer parameters was obtained using kriging and other geostatistical tools. The record of historic observed head data from 1930 to 1975 was used for the least squares fit. The algorithm had difficulty estimating realistic boundary heads for conceptualization and data for the Columbus Basin. A validation study of CERT was conducted by estimating transmissivity and/or nodal fluxes using portions of the observed head data set divided in space or time. A posterior linearized estimate of the parameter covariance matrices was also conducted. These results were used as input to the uncertainty propagation algorithm coded into CERT, and predictions of heads and head standard deviations were made over the time period 1930 to 1975. Model heads matched well with observed heads when the model input parameters were conditioned only on a portion of the observed head data. Values of the standard deviation on heads were reasonable once boundary node correlation was accounted for. (Wilson-NM Inst. Mining and Tech.)
W88-10042

4C. Effects On Water Of Man's Non-Water Activities

POTENTIAL CATION LEACHING LOSSES FOLLOWING DISTURBANCE ACROSS A SOUTHEASTERN COASTAL PLAIN LANDSCAPE GRADIENT,
D. A. Kovacic, K. W. McLeod, A. A. Leff, and T. G. Ciravolo.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 63-67, 2 fig, 1 tab.

Descriptors: *Water pollution effects, *Forests, *Cations, *Leaching, *Path of pollutants, *Coastal plains, Potassium, Calcium, Aluminum, Iron, Magnesium, Manganese, Wetlands, Nutrient cycling, South Carolina, Forests, Swamps, Lysimeters, Hydrogen ion concentration.

The purpose of this study was to compare the effects of forest disturbance on potential solution cation (K, Ca, Al, Fe, Mg and Mn) losses between upland and wetland vegetative community types along a landscape gradient on the Upper Coastal Plain of South Carolina. The habitats studied were: upland pine forest, upland deciduous forest, bottomland deciduous forest and cypress swamp. Trenching was a 'controlled' disturbance that allowed the effects of interrupting root uptake to be assessed, without changing the microclimate and with minimum disturbance to the forest floor. Studies have used trenching to determine the importance of root uptake on nutrient cycling in forest ecosystems, but few have compared these processes across vegetative community types of close proximity along a landscape gradient. The greatest lysimeter solution cation losses in the upland and bottomland deciduous sites were found following disturbance. Cation losses were greatest in the bottomland deciduous sites. Magnesium, potassium and manganese losses were negatively correlated with pH. Aluminum, manganese and iron losses following disturbance were found in the upland and bottomland deciduous sites, reflecting functional differences in cation cycling between coniferous and deciduous communities. (See also W88-09211) (Lantz-PTT)
W88-09222

DIGITAL ANALYSIS OF WATER MOVEMENT, WATER QUALITY AND LAND USE EFFECTS IN A STREAM-AQUIFER SYSTEM,
Geological Survey, Tacoma, WA.
For primary bibliographic entry see Field 2E.
W88-09273

MECHANISMS OF MASS MOVEMENT IN PERIGLACIAL ENVIRONMENTS,
University Coll., Cardiff (Wales). Dept. of Geology.
For primary bibliographic entry see Field 2J.
W88-09350

REHABILITATING DAMAGED ECOSYSTEMS.
For primary bibliographic entry see Field 5C.
W88-09448

ABANDONED MINES IN ILLINOIS AND NORTH DAKOTA: TOWARD AN UNDERSTANDING OF REVEGETATION PROBLEMS,
Illinois Natural History Survey, Champaign.
C. Grunwald, L. R. Iverson, and D. B. Szafoni.
IN: Rehabilitating Damaged Ecosystems. Volume I. CRC Press Inc., Boca Raton, Florida. 1988. p 39-59, 6 fig, 2 tab, 75 ref.

Descriptors: *Restoration, *Revegetation, *Abandoned mines, *Illinois, *Erosion control, *Rehabilitation, *North Dakota, Coal mines, Erosion control, Soil water, Organic matter, Waste disposal, Sludge, Fertilizers, Nitrogen, Carbon, Phosphorus, Potassium, Salinity, Hydrogen ion concentration, Plants.

North Dakota and Illinois rank nationally first and third, respectively, in total identified coal resources. The North Dakota coal region, located in the western part of the state, is presently mined entirely by surface mining techniques. Reclamation following coal extraction was not generally practiced until the 1969 surface mine reclamation law was enacted by the North Dakota legislature. The North Dakota regulatory authority, the Public Service Commission, recognizes 616 abandoned mine sites in the state; over 350 of these were surface mines widely distributed across the western half of the state. These sites range in size from <0.5 to 730 ha and are equally varied in condition of spoil and in vegetative cover. Similarities in conditions between the Illinois and North Dakota regions suggest overlapping strategies for reclamation. Recommendations include; (1) Reducing slopes of the waste piles, especially in Illinois where they often exceeded 35 degrees with lengths > 100 m, would stabilize the banks, prevent slumping, and greatly reduce sheet and rill erosion. Long, devegetated slopes, even though less steep, are nevertheless vulnerable to the formation of gullies; (2) The addition of organic material would help revegetation efforts by increasing the retention of moisture as well as the availability of nutrients. The addition of sewage sludge has been shown to be highly beneficial in restoring organic C, N, P, and K; (3) Careful soil sampling and analysis is essential in order to correct nutrient deficiencies and toxicities. The use of N-fixing organisms can benefit long-term N management; (4) Spoil pH plays a large role in determining the availability of nutrients; (5) Several techniques can reduce salt levels on such soils, including leaching and the incorporation of gypsum; and (6) Selection of plant species suited for growth on abandoned mines is critical to revegetation success. (See also W88-09438) (Lantz-PTT)
W88-09451

REHABILITATING DAMAGED ECOSYSTEMS.
For primary bibliographic entry see Field 5G.
W88-09457

INFLUENCE OF AGRICULTURAL PRACTICES ON GROUND WATER QUALITY IN MAINE,
Maine Geological Survey, Augusta.
For primary bibliographic entry see Field 5B.
W88-09497

EFFECTS OF LAND USE UPON WATER CHEMISTRY, PARTICULARLY NUTRIENT ENRICHMENT, IN SHALLOW LOWLAND LAKES: COMPARATIVE STUDIES OF THREE LOCHS IN SCOTLAND,
Dundee Univ. (Scotland). Dept. of Biological Sciences.
D. M. Harper, and W. D. P. Stewart.
Hydrobiologia HYDRB8, Vol. 148, No. 3, p 211-229, May 30, 1987. 5 fig, 16 tab, 60 ref.

Descriptors: *Water pollution effects, *Land use, *Agricultural runoff, *Nutrients, *Enrichment, *Lakes, *Shallow water, *Comparison studies, *Chemical properties, Phosphorus, Nitrogen, Chlorophyll a, Scotland.

Three shallow, lowland lochs (lakes) in the Tayside region of Scotland, experiencing the same climatic regime, were found to be dimictic lakes showing similar clinograde oxygen distributions in summer. Land use differences in their catchments were shown to result in estimated total nutrient surface loadings from 0.3 to 32 g/sq m/a phosphorus and from 4 to 240 g/sq m/a nitrogen. The major ions in the lochs were calcium and carbonate, but with elevated sulfate levels in all three lochs and an increase in sodium, chloride and sulfate in Forfar loch, which was affected by sewage effluent. Conductivity and total alkalinity showed marked increases with greater intensity of land use, from 64 to 439 microsigmas/sq cm and 0.5-3 meq/L. Maximum winter loch concentrations of soluble reactive phosphorus ranged from 60 to just under 5,000 mg/cu m and of inorganic nitrogen from 500 to 10,500 mg/cu m. Maximum chlorophyll a ranged from 20 to 250 mg/cu m and comparisons indicated that above winter levels of 5000 mg/cu m N and 500 mg/cu m P, the nutrient-chlorophyll relationships did not hold. Predictions of nutrient input, from land use categories and soil losses of N and P derived from other north temperate areas, were shown to be comparable with inputs calculated from loch measurements. Models predicting loch concentrations of phosphorus from inputs were comparable with measured concentrations, but predictions of chlorophyll and transparency became less accurate with higher nutrient levels. The lochs were mesotrophic (the Lowes), eutrophic (Balgavies) and hypertrophic (Forfar) under the several classification systems used. The implications of their nutrient status for lake management are discussed and the value of studying this unique lake series in a similar physical environment but with considerable chemical differences is considered. (Author's abstract)
W88-09679

HISTORICAL CHANGES OF A LARGE RIVER IN AN URBAN AREA: THE GARONNE RIVER, TOULOUSE, FRANCE,
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
M. Fortune.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 179-186, April-June 1988. 3 fig, 2 tab, 20 ref.

Descriptors: *Water management effects, *Flow pattern, *Regulated rivers, *Rivers, *Urbanization, *Flow characteristics, *River flow, Flow control, Regulated flow, Garonne River, France, Dam effects, Floods, Sedimentation, Erosion, Morphology, Environmental effects.

Man-made structures have greatly modified the flow pattern of the Garonne River at Toulouse, France, since at least the 12th century. The first of many small dams was constructed in 1182. Destructive floods regularly destroyed the dams, flooded portions of the city, changed the river course, and destroyed the wooden bridges, the first of which was probably built during the first half of the 13th century. The first stone bridge was completed in 1660, after a 100 year period of construction. After 1680 attempts to control the river led to a variety of river responses: increased sedimentation in some locations and erosion in others, a reduction in the number of islands from seventeen to four, and a 63% reduction in the length of shoreline in the urban area of Toulouse. The reduction decreased the number of possible habitats for fish and other fauna in the urban area. Uniform molassic rock replaced the heterogeneous deposits along the shores and inputs of organic matter from riparian vegetation became negligible even before the construction of embankments. The attempted management of the Garonne River was economically advantageous but led to unforeseen and costly environmental consequences. (Wood-PTT)
W88-09728

MAN AND MIRE: A LONG AND WET RELATIONSHIP,
King's Coll., London (England). Dept. of Biology.
P. D. Moore.
Transactions of the Botanical Society of Edinburgh, Vol. 45, No. 2, p 77-95, 1988. 6 fig, 47 ref.

Descriptors: *Wetlands, *Deforestation, *Mires, *Peat bogs, *Aquatic habitats, Hydrology, Surface runoff, Cycling nutrients, Peat, Stratigraphy, Pollen analysis, Paleoecology, Great Britain.

Several different types of mire (peat-forming ecosystems) contain in their stratigraphic and pollen record evidence of human activity. Often this coincides with either the commencement of peat formation or a major change in the type of peat being formed. Some mires can therefore be regarded as man-made habitats. Examples discussed include valley mires of upland and western Britain. All of these show major changes in their stratigraphy at a time when human influence, as exhibited in the pollen record, is particularly strong. The effects of man on valley mire and blanket mire initiation is mainly a consequence of hydrological change; deforestation increases the frequency of soil satura-

tion and the quantity of run-off water. The result is impaired decomposition and peat accumulation. Downwash of silts and charcoal can also enhance this effect in valley mires, as can podsolization in blanket mires. A further effect of deforestation, the nutrient enrichment of drainage waters, is shown to be of particular importance in the initiation of a floating raft of aquatics at the schwingmoor, Llyn Mire, and hence led to the development of a raft of bog vegetation over a former lake. On the basis of these examples the question of just how widespread is man's influence on mire development is discussed. (Author's abstract)
W88-09860

SESTON AND DISSOLVED ORGANIC CARBON TRANSPORT DURING STORM FLOWS IN A NATURAL AND A DISTURBED COASTAL PLAIN STREAM,
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 5B.
W88-09925

ORGANIC MATTER CONTENT IN SEDIMENTS OF THREE NAVIGATION POOLS ALONG THE UPPER MISSISSIPPI RIVER,
For primary bibliographic entry see Field 2H.
W88-09932

TEMPORAL AND SPATIAL VARIABILITY OF THE EULITTORAL EPILITHIC PERIPHYTON, LAKE TAHOE, CALIFORNIA-NEVADA,
California Univ., Davis. Div. of Environmental Studies.
For primary bibliographic entry see Field 2H.
W88-09937

STORAGE-EFFECTIVE DRAINAGE RUNOFF MODEL,
Alberta Dept. of Environment, Edmonton.
For primary bibliographic entry see Field 2A.
W88-09978

WET WEATHER WATER QUALITY MODELING,
Texas Univ. at Dallas, Richardson. Center for Environmental Studies.
J. J. Warwick, and J. D. Edgmon.
Journal of Water Resources Planning and Management JWPED5, Vol. 114, No. 3, p 313-325, May 1988. 6 fig, 4 tab, 14 ref, 2 append.

Descriptors: *Water quality, *Combined sewers, *Model studies, *Dissolved oxygen, *Urban runoff, *Urban hydrology, Rainfall-runoff relationships, Sludge, Sewers, Overflow, Oxygen.

An integrated, rainfall-runoff and runoff-receiving water-quality modeling protocol was developed to quantify the impact of combined sewer overflow events on in-stream dissolved oxygen concentration. Modeling assumptions and input data requirements are consistent with intended usage as a planning and management tool. The modeling protocol was successfully calibrated and verified using data collected from several storm events occurring during the summer and fall of 1982. The expected frequency of in-stream dissolved oxygen violation was determined from the analysis of historical records containing 208 combined sewer overflow events. 42 percent of these events resulted in minimum dissolved oxygen values below the 4.0 mg per L standard. Sludge deposit resuspension was demonstrated for a monitored high flow event when the in-stream velocity was computed as 0.689 m per s (2.26 ft per sec.). (Author's abstract)
W88-09983

RIVER RECREATION BOATING IMPACTS,
Toronto Univ. (Ontario). Dept. of Geography.
R. Jaakson.
Journal of Water Resources Planning and Management JWPED5, Vol. 114, No. 3, p 363-367, May 1988. 1 fig, 1 tab, 2 ref, 1 append.

Descriptors: *Boating, *Navigable waters, *Inland waterways, *Recreation, Rideau Canal, Navigation canals, Resources management, Rivers, Lakes, Rideau River, Water management, Lake Ontario, Canada.

This paper presents a method to identify recreational boating impacts, and discusses its management implications. Four variables to measure boating impact were identified: Vessel speed, lanes used, wake, and operational characteristics. Observations were made over a nine day period. There were an average of 234.4 boat passes per day (standard deviation 13.1, range 51-434); an average of 25.6 boat passes per hour (standard deviation 1.7, range 9.3-54.3); and an average of 42.3 boat passes per peak hour for the nine days (s.d. 2.2, range 10-67). Frequency of observed boats was: (1) Runabouts and cruisers (63.4% of total boat passes); (2) water skiers (22.3); (3) canoes and kayaks (12.0%); and (4) houseboats (1.6%). The high volume of boat traffic has considerable impact on the river recreation environment. The policy implications for are water management plan are discussed. (Roseman-PTT)
W88-09987

RAINFALL-RUNOFF DATA FOR SOMERSET COUNTY, NEW JERSEY,
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 2E.
W88-10049

HYDROLOGY OF THE WHITE TAIL BUTTE AREA, NORTHERN CAMPBELL COUNTY, WYOMING,
Geological Survey, Cheyenne, WY. Water Resources Div.
M. E. Lowry, and J. G. Rankl.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water Resources Investigations Report 82-4117, 1987. 47 p, 26 fig, 9 tab, 12 ref.

Descriptors: *Coal hydrology, *Rainfall-runoff relationships, *Coal mining impact, *Flood peak, *Powder River Basin, *Wyoming, *Surface-groundwater relations, Rainfall, Runoff, Hydrology, Reclamation, Groundwater, Water pollution sources, Groundwater pollution, Campbell County.

Quantity of runoff and peak discharge from one small basin in the White Tail Butte area, determined from a calibrated rainfall-runoff model, is less than the quantity computed using results of a regional study. The difference is caused by the extensive beds of exposed, permeable clinker in the area. Potentiometric surfaces in the White Tail Butte area indicated that, regionally, it is a discharge area. This is consistent with the conceptual model developed elsewhere in Campbell County, Wyo. The chemical quality of water from springs and alluvium, however, is characteristic of water found in recharge areas, so movement of water in the regional system is apparently small compared to local recharge. If surface coal mining occurs in the area, the principal adverse impact to the groundwater system would be the destruction of springs and seeps in the mined area. These could be restored with special reclamation procedures. There are adequate quantities of water of suitable quality for stock or domestic use below the coal so postreclamation supplies could be obtained. Impacts of surface mining on runoff could not be evaluated, but sensitivity of runoff to infiltration indicates a 10-percent change in runoff for a 1-percent change in infiltration. (USGS)
W88-10052

EFFECT OF URBANIZATION ON THE WATER RESOURCES OF EASTERN CHESTER COUNTY, PENNSYLVANIA,
Geological Survey, Malvern, PA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-10054

4D. Watershed Protection

EFFECTS OF RIPRAP BANK REINFORCEMENT ON JUVENILE SALMONIDS IN FOUR WESTERN WASHINGTON STREAMS,
Fish and Wildlife Service, Olympia, WA. Fisheries Assistance Office.
For primary bibliographic entry see Field 8I.
W88-09820

STUDY OF RUNOFF AND EROSION PROCESSES USING LARGE AND SMALL RAINFALL SIMULATORS,
New Mexico State Univ., Las Cruces. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W88-10045

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

CONSIDERATION OF TOTAL ION COMPOSITION IN DESIGNING TOXICITY TESTS USING ALUMINUM SALTS AND MINERAL ACIDS,
ADVENT Group, Brentwood, TN.
R. C. Young.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 92-97, 23 ref.

Descriptors: *Pollutant identification, *Acid rain effects, *Bioassay, *Water pollution effects, *Toxicity, *Aluminum salts, *Mineral acids, Ions, Aluminum chloride, Aluminum sulfate, Chemical analysis, Hydrogen ion concentration, Acidic waters, Water analysis.

Review of the current literature reveals that many researchers involved in the study of the effects of aluminum and pH on aquatic life are using aluminum salts (sulfate or chloride forms) to obtain the desired aluminum concentration for their experiments. This technique raises some concern for soft water experiments due to the unknown effect of excessive concentrations (in relation to background) of the associated anions SO4(2-) or Cl(-). For example, if aluminum chloride (AlCl3) is employed to obtain a concentration of 0.5 mg/L aluminum, the solution also will be increased by 2.0 mg/L Cl(-). Likewise, if aluminum sulfate (Al2(SO4)3) is used to achieve the 0.5 mg/L aluminum, SO4(2-) will be increased 2.6 mg/L. For inland streams (that is, not affected by ocean salts), these values appear to be out of proportion. In some instances the use of aluminum salts can easily double or increase by the power of 10 the concentrations of associated anion. SO4(2-) or Cl(-) concentrations are further increased by the use of sulfuric and hydrochloric acid to adjust pH. Since aluminum is an effective buffer below pH 5.0, solutions containing high concentrations of aluminum also will require larger volumes of acid to achieve pH values below this level, thus compounding the problem. The question of acid form, that is, sulfuric, hydrochloric, nitric, etc., in relation to toxicity leads to the consideration that these 'strong acids' are only one component contributing to the total acidity of a system. In coniferous forests with deep acid soils, storm water runoff could contribute significantly to the acidity of streams due to fulvic acids. Their chelating ability also could enhance the mobilization of aluminum. How these weak organic acids affect or regulate pH or pH/aluminum toxicity in fish is also unknown. This paper discusses the importance of total solute concentration and the possible role specific anions play in mediating osmoregulation in acid- and acid/aluminum-stressed fish. (See also W88-08960) (Author's abstract)

W88-08968

SIMPLE METHOD TO MEASURE PH ACCURATELY IN ACID RAIN SAMPLES,
ORION Research, Inc., Cambridge, MA.
P. F. Boyle, J. W. Ross, J. C. Symott, and C. L. James.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 98-106, 2 fig, 11 tab, 6 ref, append.

Descriptors: *Water analysis, *pH measurement, *Acidity measurement, *Acid rain, *Hydrogen ion concentration, *Pollutant identification, Chemical analysis, Measuring instruments, Conductivity, Potassium chloride, Ross exchange.

Conventional pH electrodes, which are designed to function in high-conductivity solutions, show slow and erratic response in pure water samples such as acid precipitation. Increasing conductivity without shifting pH solves the measurement problem. This method correctly measures pH in low conductivity solutions, using a Ross combination pH electrode, after the addition of a small amount of potassium chloride (KCl) solution to the sample. The Ross electrode, with its unique internal redox system, is chosen since it eliminates problems associated with temperature and because the precision and accuracy of data obtained in preliminary testing with it were comparable to those obtained with the standard hydrogen electrode. KCl addition to sample does not alter the pH significantly. (See also W88-08960) (Author's abstract)
W88-08969

PRACTICAL GUIDE FOR GROUND-WATER SAMPLING,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 7B.
W88-08974

SOIL GAS SENSING FOR DETECTION AND MAPPING OF VOLATILE ORGANICS,
Nevada Univ., Las Vegas. Environmental Research Center.
D. A. Devitt, R. B. Evans, W. A. Jury, T. R. Starks, and B. Eklund.
National Water Well Association, Dublin, Ohio. 1987. 270 p, 80 fig, 34 tab, 143 ref.

Descriptors: *Path of pollutants, *Gas sensing, *Volatile acids, *Organic compounds, *Monitoring, *Soil contamination, *Groundwater pollution, Fate of pollutants, Statistical studies, Case studies.

Soil gas monitoring has been shown to be a cost effective means of delineating the size and movement of organic contaminants in the subsurface. It has also been shown to provide immediate information of the lateral extent of soil and groundwater contamination and to minimize and more accurately predict the number and location of conventional monitoring wells that must be drilled. The document begins by outlining many of the parameters (water solubility, microbial influence, groundwater flow, etc.) that must be considered by the scientist before utilizing soil gas sensors in a field monitoring program. Next, the complex soil, air, water and hydrocarbon system is addressed with an overview of the important processes involved in the transport and fate of organic contaminants in the soil. Additional sections address the correct sampling and analytical methodologies for monitoring volatile organics in the subsurface, covering such sampling methods as headspace, ground probe, flux chamber and passive sampling techniques. Analytical methodologies covered outline the most appropriate methods to utilize for a given contaminant monitoring program. A statistical treatment of soil organic vapor measurements is also included to ensure that soil gas monitoring programs address the requirement for data precision. The statistical section also gives greater insight into understanding the spatial patterns of soil organic vapor measurements. Finally, case studies are included to give the unfamiliar reader examples of the design, procedures and results of soil gas monitoring programs that have been successful in delineating the size and lateral extent of a subsurface organic contaminants. (Lantz-PTT)
W88-08978

1987 ANNUAL BOOK OF ASTM STANDARDS.
American Society for Testing and Materials, Philadelphia, PA.
Volume 11.02: Water (II). American Society for Testing Materials, Philadelphia, PA. 1987. 1083 p.

Descriptors: *Standards, *Pollutant identification, *Water treatment, *Wastewater treatment, Organic compounds, Radioactivity, Brackish water, Brines, Saline water, Microbiological studies, Chemical analysis, Filters, Membranes, Chemical treatment, Reverse osmosis, Ion exchange.

The standard methods for study of water in this volume are under the jurisdiction of ASTM Committee D-19 on Water. This committee is concerned with the study of water, the promotion of such knowledge, and the standardization of terminology and methods for: (1) sampling and analysis of water, water-borne materials and wastes, water-formed deposits; (2) the determination of the structure, function, and condition of communities of indigenous and other aquatic organisms; (3) surface water hydraulics and hydrologic measurements; (4) the determination of the performance of materials used to modify water characteristics; and (5) the determination of the corrosivity or deposit-forming properties of water. Standards in this volume cover the following categories: (1) organic constituents; (2) radioactivity; (3) saline and brackish waters, seawaters, and brines; (4) microbiological examination; (5) water-formed deposits; and (6) water-treatment materials (chemicals, particulate ion exchange materials, membrane filters, membranes, and reverse osmosis). (See also W88-08986 and W88-08988) (Lantz-PTT)
W88-08987

DECONTAMINATION OF RUBBER HOSE AND 'TEFLON' TUBING FOR GROUND WATER SAMPLING,
California Regional Water Quality Control Board, Sacramento. Central Valley Region.
R. J. Matteoli, and J. M. Noonan.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 159-183. 11 fig, 8 tab, 5 ref.

Descriptors: *Quality control, *Decontamination, *Sampling devices, *Groundwater monitoring, *Monitoring wells, *Groundwater pollution, Heavy metal, Aquifers, Groundwater management, Organic compounds, Analytical methods, Measuring instruments, Groundwater.

Water was pumped from wells known to have high concentrations of contaminants with a stainless steel, submersible pump through a rubber hose or a 'Teflon' tube to a discharge point above ground surface. Water samples were collected at the discharge point. The exterior of the pumping equipment was steam cleaned and then reinstalled in a well known to have a nondetectable concentration of the contaminant. Water was pumped from this well and samples were collected from the discharge. Four replicates of each contamination/decontamination cycle were run. Bailer samples were collected from each well with a 'Teflon' bailer before installation of the pumping equipment. The results of these investigations of contamination and decontamination of portable (non-dedicated) pumping equipment with contaminants representative of California Regional Water Quality Control Board projects are presented. The authors studied contamination and decontamination of a submersible pump and a 200 foot rubber hose with trichloroethylene (TCE) and contamination and decontamination of the same submersible pump and a 200 foot FEP 'Teflon' polymer tube with TCE; 1,1,2-trichloro-2,2,1-trifluoroethane (Freon 113); 1,1-dichloroethylene (1,1-DCE); dimethylnitrosamine (DMNA); selenium; and chromium. More than three hours of rinsing with clean water are required to bring TCE to below detection limits for the submersible pump-rubber hose combination. A significant potential appears to exist for equipment-induced false positive results with nondedicated pumping systems that deliver water to the surface for sampling. (See also W88-08991) (Author's abstract)
W88-09000

INSTALLATION OF A SEDIMENT-FREE MONITORING WELL IN FINE-GRAINED SEDIMENT,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
For primary bibliographic entry see Field 7B.
W88-09009

GUIDE TO THE SELECTION OF CEMENT, BENTONITE AND OTHER ADDITIVES FOR USE IN MONITOR WELL CONSTRUCTION,
California Regional Water Quality Control Board, Sacramento. Central Valley Region.
For primary bibliographic entry see Field 7B.
W88-09010

CEMENT BENTONITE GROUT AND ITS EFFECT ON WATER QUALITY SAMPLES: A FIELD TEST OF VOLCLAY GROUT,
For primary bibliographic entry see Field 7B.
W88-09011

USE OF ODEX DRILLING SYSTEM FOR MONITORING WELL INSTALLATION IN AQUIFER CONTAINING GLACIAL BOULDERS,
For primary bibliographic entry see Field 7A.
W88-09012

USING THE DRILL THROUGH CASING HAMMER METHOD FOR MONITORING WELL CONSTRUCTION AND WATER QUALITY CHARACTERIZATION IN A METAL CONTAMINATED GRAVEL, COBBLE AND BOULDER AQUIFER,
Montana Univ., Missoula. Dept. of Geology.
For primary bibliographic entry see Field 7B.
W88-09013

USE OF A MATHEMATICAL MODEL TO DESIGN LYSIMETER NETWORKS FOR SURFACE IMPOUNDMENTS AND LANDFILLS,
In-Situ, Inc., Laramie, WY.
For primary bibliographic entry see Field 7A.
W88-09014

FACTORS AFFECTING THE UTILITY OF SOIL VAPOR ASSESSMENT DATA,
EA Engineering, Science, and Technology, Inc., Sparks, MD.
For primary bibliographic entry see Field 7A.
W88-09015

SOIL GAS SAMPLING STRATEGIES: DEEP VS. SHALLOW AQUIFERS,
For primary bibliographic entry see Field 7A.
W88-09016

NEUTRON MONITORING IN THE UNSATURATED ZONE,
LeRoy Crandall and Associates, Glendale, CA.
For primary bibliographic entry see Field 7A.
W88-09017

CHARACTERIZATION OF AN ABANDONED WASTE SITE USING PROTON MAGNETOMETRY AND COMPUTER GRAPHICS,
J. F. Blasting.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 573-584. 6 fig, 1 ref.

Descriptors: *Geophysics, *Landfills, *Mapping, *Magnetic studies, *Cleanup operations, *Magnetometry, *Measuring instruments, *Geohydrology, *Groundwater monitoring, *Groundwater pollution, Groundwater management, Computer programs, Analytical methods, Data interpretation, Monitoring wells, Cost-benefit analysis, Economic aspects, Surveys, Groundwater, Glacial aquifers.

Hart Environmental Management Corporation was retained to characterize a potential hazardous waste site and design a program of remediation for this site. Hart utilized a portable proton magnetometer in combination with computer drafting equipment to determine the location and extent of drum burial and subsequently design drum excavation and groundwater monitoring programs. Direct magnetic field (DMF) and gradient magnetic field (GMF) surveys which traverse the entire site were conducted. A Unimag II Portable Proton Magnetometer (Model G-846) was used to conduct these surveys. AutoCAD (Version 2.5) software, was utilized to reduce survey data and produce DMF and GMF contour maps. These maps indicated a large magnetic anomaly in the northwest corner of the site. A second DMF survey was conducted in this area to enhance the detail of the anomaly. The resulting computer-drafted contour map was used to design a program of excavation and drum removal. The excavation program exhumed 164 drums containing paint, paint sludge, and solvents. The location of each drum was referenced to the existing grid and a computer-drafted map of drum locations was produced. Comparison of the drum location map to the DMF contour map shows a direct, accurate correlation between magnetic anomalies and buried drums. The entire program of magnetometry surveys and computer drafting took six days to complete. The resulting information was used to reduce the excavation area from approximately two and one-half acres to a third of an acre. Substantial savings in time and money were realized by coordinating state-of-the-art field and office techniques. (See also W88-08991) (Author's abstract)
W88-09024

USE OF AN ELECTROMAGNETIC INDUCTION TECHNIQUE IN SUBSURFACE HYDROCARBON INVESTIGATIONS,
W. R. Saunders, and S. A. Cox.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 585-599. 5 fig, 2 tab, 6 ref.

Descriptors: *Leakage, *Path of pollutants, *Mapping, *Magnetic studies, *Fuel spills, *Measuring instruments, *Remote sensing, *Groundwater monitoring, *Groundwater pollution, *Geophysics, *Geohydrology, Model studies, Monitoring wells, Hydrocarbons, Cost-benefit analysis, Economic aspects, Organic compounds, Data interpretation, Groundwater, Analytical methods, Groundwater management, Monitoring, North Carolina, Airports.

Of major environmental concern at many Federal and publicly operated airport facilities is the contamination of subsurface soils and groundwater from leakage by buried pipelines and underground fuel storage tanks. A common approach to many subsurface contamination problems at these and other facilities is the installation of numerous groundwater monitoring wells to characterize the local hydrogeology, groundwater quality, and the presence or absence of free floating product (JP-4 fuel) in the monitoring wells. The implementation of an electromagnetic (EM) induction technique at a United States Air Force facility located in the eastern is discussed. The use of an electromagnetic induction technique for delineating areas of subsurface hydrocarbon accumulations is a cost effective and viable investigative technique at some sites. The data indicates that there are multiple sources of subsurface hydrocarbons in the survey area, including the fuel hydrant pits, leakage through and into storm drainage lines and associated trenches, and surface spills and underground storage tanks near the pumping stations. Theorectical models developed by the manufacturer of the EM-31D to document the response of the EM-31D to changes in subsurface conductivity indicate that relatively thin layers of low conductive materials within a conductive environment will not be detected. (See also W88-08991) (Alexander-PTT)
W88-09025

USE OF TIME DOMAIN ELECTROMAGNETIC SOUNDINGS FOR MAPPING SEA WATER INTRUSION IN MONTEREY CO., CA.: A CASE HISTORY,
Monterey County Food Control and Water Conservation District, Salinas, CA.
T. Mills, L. Evans, and M. Blohm.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 601-621. 23 fig.

Descriptors: *Geophysics, *Electromagnetic studies, *Mapping, *Isochlors, *Magnetic studies, *Saline water intrusion, *Groundwater monitoring, *Measuring instruments, *Geohydrology, Water quality, Path of pollutants, Data interpretation, Saline-freshwater interfaces, Groundwater, Correlation, California, Groundwater management, Monitoring wells, Analytical methods.

In November 1986 a surface geophysical survey was performed in Monterey County, California, using Time Domain Electromagnetic (TDEM) soundings. This monitoring program had found that of the three aquifers in the study area, two aquifers, the '180-foot' and the '400-foot', had been intruded. The third aquifer, the '900-foot' aquifer, had not shown signs of sea-water intrusion. Surface geophysics was used to obtain information about water quality between monitoring wells and to contour the position of the 500-ppm isochlor in both of the upper aquifers. A total of 100 soundings were measured in the project area, requiring three weeks of field work. The soundings were located by using the information already available from monitoring wells. Lines of soundings were run perpendicular to the anticipated position of the 500-ppm isochlor in an attempt to better define the location of the isochlor. In addition, several soundings were measured adjacent to water quality wells to aid in correlating the information obtained with surface geophysics to the known water quality data. This procedure permitted the position of the 500-ppm isochlor to be mapped in both aquifers. In addition, information about the depth to the saline contamination was obtained throughout the project area. (See also W88-08991) (Author's abstract)
W88-09026

GEOPHYSICAL GROUND WATER MONITORING PROGRAM FOR A SANITARY LANDFILL: IMPLEMENTATION AND PRELIMINARY ANALYSIS,
GeoTrans, Inc., Herndon, VA.
J. O. Rumbaugh, J. A. Caldwell, and S. T. Shaw.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 623-641. 17 fig, 1 tab, 8 ref.

Descriptors: *Resistivity, *Mapping, *Magnetic studies, *Landfills, *Geophysics, *Geohydrology, *Groundwater monitoring, *Groundwater pollution, *Leachates, *Measuring instruments, *Remote sensing, Soil water, Data interpretation, Water pollution sources, Waste disposal, Aquifers, Groundwater, Maryland, Monitoring, Seasonal variation, Analytical methods, Groundwater management.

Maryland's Montgomery County government has recently implemented a geophysical monitoring program for the Oaks Landfill near Gaithersburg. The geophysical monitoring program was designed with the assumption that there is no groundwater contamination from landfill leachate at the present time. The landfill has been in operation only since 1982 and no contamination has been encountered in the groundwater monitoring network. Monitoring began in September 1986 with data being collected bimonthly for one year to assess seasonal variation in the geophysical measurements. Electromagnetic (EM) and resistivity data collected thus far indicate that there is no obvious leachate contamination of groundwater at the site. The readings are very consistent from survey to survey exhibiting some seasonal variation (+ or - 30 percent) due to changes in soil moisture content and water table fluctuations. The preliminary results indicate that the geophysical data are reproducible and consistent over time. Geophysical data collected at a nearby landfill where leachate contamination is known to exist indicate that apparent conductivities in a contaminated area are three to five times higher than in background areas. In a shallow groundwater system such as the Oaks Landfill site geophysical monitoring appears to be a viable method of enhancing a groundwater monitoring system. (See also W88-08991) (Author's abstract)
W88-09027

WATER MANAGEMENT FOR QUALITY AND QUANTITY: ITS RELATION TO DATA GATHERING AND DATA MANAGEMENT,
For primary bibliographic entry see Field 7C.
W88-09040

MONITORING COASTAL WATERS ENVIRONMENTAL QUALITY: THE U.S. NATIONAL STATUS AND TRENDS PROGRAM,
For primary bibliographic entry see Field 7A.
W88-09041

ROLE OF THE FISH AND WILDLIFE SERVICE IN WATER-QUALITY MONITORING,
For primary bibliographic entry see Field 7B.
W88-09042

DETERMINATION OF CHLOROPHENOXY ACID HERBICIDES BY LIQUID CHROMATOGRAPHY USING CARBON-14 TRACERS,
Oak Ridge National Lab., TN. Analytical Chemistry Div.
R. Merriweather, W. M. Caldwell, M. P. Maskarinec, and J. E. Caton.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-011932. Price codes: A02 in paper copy, A01 in microfiche. 1987. 8 p, 1 tab, 6 ref. Contract No. DE-AC05-84OR21400.

Descriptors: *Pollutant identification, *Herbicides, *Silvex, *2,4-D, *Liquid chromatography, Extraction, Chlorinated hydrocarbons, Separation techniques, Carbon radioisotopes, Radioactive tracers, Hydrogen ion concentration.

The exractive recovery of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2- (2,4-5-trichloro)phenoxypropionic acid (Silvex) from environmental samples was evaluated using carbon-14 tracers of the acid form of both herbicides. Recoveries using methylene chloride or 1:1 methylene chloride:acetone for solids exceeded 75% when the material being extracted was maintained at an acid pH (pH $<$ or $=$ 2). Following extraction, the extract is taken to dryness and then dissolved in the solution being used for high pressure liquid chromatography elution. Two slightly different isocratic elutions with reversed phase columns were studied. In the first system studied a heavily loaded (18% carbon by weight), completely endcapped C18 reversed phase column was eluted with an aqueous solution of 30% (v/v) acetonitrile that contained 0.001 M concentration of a pH 4.6 acetate buffer. The effluent from this column was monitored at 280 nm. The minimum amount detected, when monitoring at 280 nm, is 100 ng of either Silvex or 2,4-D in the injected sample. A second isocratic elution system avoided the use of a buffered eluent by utilizing a high performance reversed phase column and an aqueous methanol (20% v/v) eluent. This second column has been monitored at multiple wavelengths with a diode array detector. The sensitivity of detection can be greatly increased at wavelengths below 240 nm; however, any real sample

must be very clean in order to avoid interferences when monitoring below 230 nm. Thus monitoring at 280 nm is probably optimal for real environmental samples. At this wavelength the detectable concentration of either herbicide in the solution being injected is 5 ppm for a 20 microliter injection. (Author's abstract)
W88-09054

MONITORING TO SUPPORT RISK ASSESSMENTS AT HAZARDOUS WASTE SITES,
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 7A.
W88-09062

PESTICIDES: MINIMIZING THE RISKS.
For primary bibliographic entry see Field 5C.
W88-09082

MONITOR WELL INSTALLATION AT K-1407-B AND K-1407-C SURFACE IMPOUNDMENTS AT THE OAK RIDGE GASEOUS DIFFUSION PLANT,
Geraghty and Miller, Inc., Oak Ridge, TN.
For primary bibliographic entry see Field 7A.
W88-09086

SAFETY EVALUATION OF PESTICIDES IN GROUND WATER,
CIBA-GEIGY Corp., Greensboro, NC. Agricultural Div.
D. D. Sumner, and J. T. Stevens.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 436-444, 2 tab, 36 ref.

Descriptors: *Pesticides, *Water quality standards, *Water quality, *Water quality control, *Groundwater, *Pollutant identification, Safety, Groundwater pollution, Evaluation, Toxicity.

As the sensitivity of analytical methods increases, more instances of pesticide detection in groundwater will occur. In order to avoid a series of crisis situations, it is necessary that standardized procedures for the identification of safe levels of chemicals in groundwater be established. The same basic principles used to establish safe levels in food, can be used to establish safe levels in groundwater. The methods used by the National Academy of Sciences to establish an Acceptable Daily Intake (ADI) and the National Agricultural Chemical Association which used an EPA database to make safe level recommendations are discussed. It is suggested that the setting of acceptable levels at zero or limits of detection, should be avoided since practical considerations preclude these approaches. It is also recommended that in order to avoid a crisis every time a pesticide is detected in the groundwater, maximum acceptable levels, based on toxicology data which is independent of analytical technique, be set before samples are analyzed. (See also W88-09089) (Wood-PTT)
W88-09112

GROUND WATER CONTAMINATION BY TOXIC SUBSTANCES: A CALIFORNIA ASSESSMENT,
California State Water Resources Control Board, Scaramento. Pollutant Investigations Branch.
D. B. Cohen.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 499-529, 12 fig, 3 tab, 28 ref.

Descriptors: *Pesticides, *Water quality control, *Water quality, *Pollutant identification, *Monitoring, *Groundwater pollution, *Toxicity, *Legal aspects, Legislation, Regulations, Agricultural chemicals, Groundwater, California, Pesticide toxicity, Risks, Water quality management, Nematicides, Hot Spots Program, 1,2-dibromo-3-chloropropane.

Overoptimistic risk perception, coupled with inadequate risk assessment, has led to underprotective risk management of toxic chemicals in groundwater. In California, soil nematicides like 1,2-dibromo-3-chloropropane (DBCP), are a particular concern. DBCP use was banned in 1977, yet it is still found in over 2500 wells. An estimated 700,000 people in 32 towns are either drinking water with measurable levels of DBCP or have had to seek alternative water supplies. Over 50 other pesticides including 1,2-D, EDB, and aldicarb were found in California groundwater from both point and nonpoint sources. Future risk management strategies must be based on a more conservative risk perception approach. California Water Resources Control Board's groundwater 'hot spots' program, an example of a systematic method for identifying emerging groundwater contamination problems before they become environmental crises, is described. It is based on screening, ranking, and assessing chemicals and sites likely to contain contaminated soil and groundwater using toxicology, physical and chemical characteristics, and environmental fate information for evaluating individual chemicals and amount of chemical applied, well logs, hydrogeology, and other data for site rating. (See also W88-09089) (Wood-PTT)
W88-09116

FIELD MEASUREMENT OF POLYCHLORINATED BIPHENYLS IN SOIL AND SEDIMENT USING A PORTABLE GAS CHROMATOGRAPH,
Environmental Protection Agency, Lexington, MA. Region 1
T. M. Spittler.
IN: Environmental Sampling for Hazardous Wastes. American Chemical Society, Washington, DC. 1984. p 37-42, 7 fig.

Descriptors: *Gas chromatography, *Pollutant identification, *Measuring techniques, *Polychlorinated biphenyls, *Soil contamination, *Sediment contamination, Sediments, Reproducibility, Detection limits, Field tests, Measuring instruments.

The EPA Region 1 Laboratory at Lexington, Massachusetts, developed a rapid field method for measuring the presence of PCBs in soil and sediments. The analytical technique is gas chromatography using the linearized electron capture detector (GC/EC). If preheated using AC power, the oven can maintain 200 C for 8 hours on battery operation and the batteries can be recharged overnight for additional 8 hour periods of use. For PCB measurements a 4 foot by 1/8 inch stainless steel column packed with 3% SE-30 on 80/100 mesh chromosorb W-HP was used. Various solvent mixtures were tested for extraction efficiency and water:methanol:hexane (1:4:5) gave almost complete recovery of the test sample of Arochlor 1242 from dry sediment. Reproducible measurements at PCB levels ranging from less than .2 ppm to 24,000 ppm of Alochlor 1254 were obtained in the field with most sample runs completed in less than 9 minutes each. (See also W88-09120) (Wood-PTT)
W88-09124

STATISTICAL METHODS IN ENVIRONMENTAL SAMPLING,
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 7A.
W88-09125

QUALITY ASSURANCE FOR A MEASUREMENT PROGRAM,
National Bureau of Standards, Washington, DC.
For primary bibliographic entry see Field 7A.
W88-09126

DETECTING ELEVATED CONTAMINATION BY COMPARISONS WITH BACKGROUND,
National Bureau of Standards, Washington, DC.
For primary bibliographic entry see Field 7A.
W88-09128

SUBSURFACE HYDROCARBON SPILL, IDENTIFICATION AND RECOVERY,
J. R. Quince.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 47-50.

Descriptors: *Water pollution treatment, *Hydrocarbons, *Groundwater pollution, *French drains, *Oil spills, *Cleanup operations, *Monitoring, *Storage tanks, *Path of Pollutants, Remedies, Waste recovery, Artificial recharge, Hydraulic engineering, Wells, Surfactants, Barriers.

Many of the old and deteriorating storage and distribution systems for hydrocarbons represent actual and potential sources of serious environmental contamination. Hydrocarbon losses can potentially occur during raw material exploration and development, crude oil transportation, storage and refinement, and subsequent product distribution, storage and use. Periodic monitoring and testing of underground storage tanks is critical, and should include, per a program developed by O.H. Materials Co., historical review of information, fuel quality testing, and regular equipment maintenance. Two critical aspects of spill identification are source of contamination and defining of site hydrogeologic conditions and the lateral and vertical extent of the spill. Investigative considerations should include the migration pathways, product volume and static groundwater levels. Remedial action must involve the use of French drains installed downgradient of the spill, recovery wells utilizing a single pump, artificial recharge, hydraulic barriers, use of surfactants for the removal of residue, and use of an oil-water separation treatment. (See also W88-09129) (Friedmann-PTT)
W88-09135

DEALING WITH THE PROBLEM OF OBTAINING ACCURATE GROUND-WATER QUALITY ANALYTICAL RESULTS,
For primary bibliographic entry see Field 7A.
W88-09162

INACCURATE WATER-QUALITY DATA IN GROUND-WATER STUDIES,
Western Water Consultants, Inc., Sheridan, WY.
For primary bibliographic entry see Field 7A.
W88-09163

CORRELATION OF GEOPHYSICAL AND ORGANIC VAPOR ANALYZER DATA OVER A CONDUCTIVE PLUME CONTAINING VOLATILE ORGANICS,
Technos, Inc., Miami, FL.
For primary bibliographic entry see Field 7A.
W88-09178

UTILIZATION OF SELECTIVE DISSOLUTION METHODS FOR ASSESSING 137-CS MOBILITY AND BIOAVAILABILITY,
For primary bibliographic entry see Field 7B.
W88-09213

USE OF STATIC SOIL VAPOR COLLECTORS TO IDENTIFY SUBSURFACE CONTAMINATION IN SOUTHERN CALIFORNIA GROUND WATER BASINS,
Mills (William B.) and Associates, Placentia, CA.
W. R. Mills.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 71-87. 8 fig, 3 ref.

Descriptors: *Soil gases, *Analytical methods, *Sampling devices, *Groundwater monitoring, *Groundwater pollution, *Organic compounds, *Chlorinated hydrocarbons, Surface drainage, Infiltration, Economic aspects, Performance evaluation, Aquifers, Rainfall, Groundwater, California, Tetrachloroethylene, Perchloroethylene, Costs.

A direct method for trapping and detecting volatile organic compounds contained in the soil pore atmosphere to confirm and detect subsurface contamination consists of a static trapping device which is placed just below the ground surface and

left in the ground for a period of three to six weeks to ensure time-integrated collection of gas flux data. Soil gas surveys were conducted near an active military airfield in Orange County, California. In the first survey, about 50 collectors were implanted over a four square mile area. Results from the survey were inconclusive in identifying the source and extent of low level tetrachloroethylene (TCE) groundwater contamination detected in two irrigation wells located down hydraulic gradient from the military installation. Survey results, however, identified (PCE) perchloroethylene contamination associated with all four surface water drainage courses serving the military installation. The inability of the soil gas collectors to detect TCE was attributed to low concentrations of contaminants, fine grained soils, and frequent applications of irrigation water in the study area. Soil gas survey results at the San Bernardino site confirmed known groundwater contamination (TCE and PCE), and provided preliminary information on potential subsurface contamination at two proposed well sites. Rainfall infiltration appeared to affect and retard the soil gas collection process at the start of the investigation. The static soil gas collection and identification technique has proven to be a useful and cost-effective means of determining contamination over large areas. If viewed as a reconnaissance investigative tool, the method can provide a basis for remedial action and reduce overall exploratory costs when properly supplemented with conventional drilling and sampling programs. (See also W88-09283) (Author's abstract)
W88-09290

EFFECTS OF FILTRATION METHOD AND SAMPLING DEVICES ON INORGANIC CHEMISTRY OF SAMPLED WELL WATER,
RMT, Inc., Madison, WI.
T. R. Stolzenburg, and D. G. Nichols.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 216-234. 5 fig, 3 tab, 19 ref.

Descriptors: *Iron, *Filtration, *Analytical methods, *Sampling devices, *Trace metals, *Water chemistry, *Water quality, *Alkaline water, Permeability coefficient, Pumps, Groundwater monitoring, Monitoring wells, Hydrology, Geohydrology, Aquifers, Performance evaluation, Oxidation-reduction potential, Groundwater.

A laboratory experiment was conducted to determine the effect of sampling device type and filtration method on dissolved iron and trace metal concentrations sampled from a well. In particular, the experiment simulated a shallow, slightly alkaline, chemically reducing well water situation. The sampling devices tested included: bailer, peristaltic pump, bladder pump, vacuum pump, gas drive pump, nitrogen lift pump, air lift pump, surface centrifugal pump, and submersible centrifugal pump. The filtration methods tested included on-line filtration, vacuum filtration following transfer from a holding vessel, and the same vacuum filtration procedure after a 10-minute holding time. Turbulence and mixing of sample water with the atmosphere causes aeration and oxidation of dissolved ferrous to ferric iron. Ferric iron rapidly precipitates as amorphous iron hydroxide and can adsorb other dissolved trace metals; hence, transfer of sample water before filtration can cause losses of dissolved metals. In fact the results of the experiment showed that the filtration step can cause at least as much sample disturbance as the sampling device itself. In-line filtration is preferable to methods which require transfer of sampled water prior to filtration. (See also W88-09283) (Author's abstract)
W88-09299

FIELD EVALUATION OF GROUND WATER SAMPLING DEVICES FOR VOLATILE ORGANIC COMPOUNDS,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
C. F. Muska, W. P. Colven, V. D. Jones, J. T. Scogin, and B. B. Looney.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 235-246. DOE Contract DE-AC09-765R00001.

Descriptors: *Sampling devices, *Measuring instruments, *Groundwater monitoring, *Groundwater pollution, *Monitoring wells, *Organic compounds, *Chlorinated hydrocarbons, Analytical methods, Economic aspects, Statistical methods, Data interpretation, Aquifers, Performance evaluation, Geohydrology, Savannah River Plant, Hydrology, Design criteria, Design standards, Groundwater, South Carolina, Trichloroethylene, Tetrachloroethylene.

The purpose of this study was to evaluate both commercial and developmental groundwater sampling devices as part of an ongoing groundwater contamination investigation and remediation program at the Savannah River Plant (SRP). Groundwater samples were collected using six types of sampling devices in monitoring wells of different depths and concentrations of volatile organic contaminants (primarily trichloroethylene and tetrachloroethylene). The study matrix was designed to compare statistically the results of each sampling device under the test conditions. Quantitative and qualitative evaluation criteria were used to determine the relative performance of each device. Two categories of sampling devices were evaluated in this field study, positive displacement pumps and grab samplers. The positive displacement pumps consisted of a centrifugal pump and a bladder pump. The grab samplers tested were a syringe sampler, a dual-check valve bailer, a surface bomb sampler, and a pressurized bailer. Preliminary studies were conducted to establish the analytical and sampling variability associated with each device. All six devices were then used to collect groundwater samples in water table (unconfined), semi-confined aquifer, and confined aquifer monitoring wells. Results were evaluated against a set of criteria which included intrasampling device variability (precision), volatile organic concentration (accuracy), sampling and analytical logistics, and cost. The study showed that, by using careful and reproducible procedures, overall sampling variability is low regardless of sampling device. Depending on the situation, the study demonstrated that sampling logistics and cost criteria outweigh small quantitative differences in the selection of a sampling device. (See also W88-09283) (Author's abstract)
W88-09300

GROUND WATER SAMPLING WITHOUT WELLS,
Montgomery (J.M.) Consulting Engineers, Inc., Irvine, CA.
K. E. Cordry.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 262-271. 4 fig.

Descriptors: *Drilling, *Hydropunch, *Groundwater monitoring, *Analytical methods, *Monitoring wells, *Sampling, *Sampling devices, *Measuring instruments, Groundwater management, Path of pollutants, Geohydrology, Hydrology, Economic aspects, Performance evaluation, Aquifers, Groundwater.

A new groundwater sampling system (the Hydropunch) has been developed which provides a rapid, cost-effective means to determine the presence of groundwater contamination, to define the vertical and horizontal extent of contamination and to accurately quantify the concentration of pollutants in the groundwater. The sampling tool provides a discrete, chemically representative groundwater sample without drilling, installation, development and sampling of a groundwater monitoring well. A 1 liter groundwater sample consistent with sampling requirements for the analysis of volatile and extractable organic and heavy metal priority pollutants is provided by the new system. The tool can be used to eliminate unneeded monitoring wells and to optimize the location of those that are required for permanent groundwater monitoring purposes. The Hydropunch is designed to be used in two modes. Where the site geology is suitable for cone penetrometer soundings (normally characterized by relatively soft, fine to medium textured soils), the sampling tool can be rapidly pushed to the desired sampling depth by the penetrometer rig. When used in this manner, the Hydropunch can typically collect a groundwater sample from 5 to over 70 feet below the ground surface in less than 1 hour. Unlike conventional monitor well installations, use of the Hydropunch system with a cone penetrometer rig results in minimal impact to the surrounding environment. The new system does not produce drill cuttings, eliminating the need for disposal of contaminated soils and greatly reducing clean-up and decontamination costs. (See also W88-09283) (Author's abstract)
W88-09302

USE OF ONSITE ANALYTICAL LABORATORY INSTRUMENTATION TO DETERMINE THE EXTENT OF CONTAMINATION AT A HAZARDOUS WASTE SITE,
Camp, Dresser and McKee, Inc., Atlanta, GA.
C. H. Lee, P. G. Johnson, and R. C. Johnson.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 272-286. 7 fig, 3 ref.

Descriptors: *Mobile laboratories, *Hazardous wastes, *Groundwater monitoring, *Groundwater pollution, *Monitoring wells, *Analytical methods, *Measuring instruments, *Field tests, *Sampling devices, Organic compounds, Chlorinated hydrocarbons, Detection limits, Economic aspects, Remedial investigations, Contract Laboratories Program, Feasibility studies, Phenols, Groundwater.

In EPA Region IV, a remedial investigation was recently completed at a wood preserving site for EPA using a different concept in order to complete the remedial investigations/feasibility studies in approximately one year. The extent of pentachlorophenol (PCP) contaminated soil and groundwater was determined in only one drilling, sampling, and analytical episode through the use of analytical instruments in an onsite trailer especially equipped for field applications on contaminated waste sites. Various portable field instruments, such as an HNu, organic vapor analyzer (OVA), X-ray fluorescence, infra-red (IR), ultra violet (UV), and gas chromatograph (GC), were evaluated for analyses of PCP, and metals. Analysis protocols and detection limits were determined for each instrument so that extent of contamination screening could be completed with a minimum of required Contract Laboratories Program laboratory analyses. The rapid turnaround time afforded by such onsite testing facilities totally dedicated to the project resulted in considerable savings in analytical costs, in mobilization costs for drilling crews and field sampling teams, equipment rental costs, and sample shipping. The concept also resulted in reduction in total project time of at least 6 months. (See also W88-09283) (Author's abstract)
W88-09303

RAPID GROUND WATER ASSESSMENT USING A MOBILE LABORATORY,
O.H. Materials Corp., Findlay, OH.
T. E. Gran, J. D. Johnston, and G. B. Reedy.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 287-290.

Descriptors: *Mobile laboratories, *Landfills, *Analytical methods, *Sampling devices, *Measuring instruments, *Groundwater monitoring, *Groundwater pollution, Economic aspects, Performance evaluation, Organic compounds, Aquifers, Monitoring wells, National Priorities List, Contract Laboratories Program, Groundwater.

In an effort to speed the evaluation of potential waste sites for inclusion on the National Priorities List (NPL), EPA Region IV implemented a program using mobile analytical laboratories to expedite sampling, analysis, and data reduction. The concept, developed with OHM, uses a dedicated, centrally-located mobile laboratory and allows sampling teams to focus work efforts in a specific geographic area. This paper describes the approach taken and the conclusions drawn concerning this type of program. The goal of this project was to rapidly screen up to one hundred sites and determine if further in-depth analysis was warranted to designate the sites for the NPL. Normally, these samples would be sent to the Region's ESD or participating laboratories in the Contract Laboratories Program (CLP) for comprehensive analysis. However, many samples submitted in past years showed little or no contamination. This information was derived only after the relatively high cost and long time frame required to provide the comprehensive laboratory services offered by CLP. The mobile laboratory screening program offers an interim service which differentiates between 'problem' sites and those requiring little or no attention. In most cases, the inorganic analytical data can be used to list sites directly on the NPL. Those sites which were contaminated with organics only are targeted for a limited resampling using the mobile laboratory data as sampling location indicators. These follow-up samples are analyzed at the Regional ESD or sent through the CLP program. Those sites which were determined 'clean' are removed from further consideration. (See also W88-09283) (Author's abstract)
W88-09304

RATIONALE FOR FILTRATION OF GROUND WATER SAMPLES,
Geraghty and Miller, Inc., Syosset, NY.
For primary bibliographic entry see Field 7B.
W88-09305

SHOULD GROUND WATER SAMPLES FROM MONITORING WELLS BE FILTERED BEFORE LABORATORY ANALYSIS, YES AND NO,
New Jersey Dept. of Environmental Protection, Trenton.
J. J. Trela.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 295-300. 5 ref.

Descriptors: *Filtration, *Chemical analysis, *Analytical methods, *Monitoring wells, *Sampling devices, *Measuring instruments, *Groundwater monitoring, *Groundwater pollution, Data interpretation, Monitoring wells, Aquifers, Groundwater.

Sample filtration is not the correct solution for deteriorated, poorly-developed or poorly constructed wells that produce turbid samples. Post-sampling precipitates should be redissolved by acidification and not filtered. In the limited number of legitimate cases where turbidity is a problem, split samples should be collected and a filtered sample should only be analyzed when there is a regulatory or public health reason to do so. Simple 'yes or no' mechanical procedures should not be used to address the filtering of groundwater samples. Documentation should be required of the actual procedures used under given circumstances so that analytical results may be properly interpreted. (See also W88-09283) (Author's abstract)
W88-09306

POSITIVE ASPECTS OF SAMPLE FILTRATION,
Jordan (Edward C.) Co., Inc., Portland, ME.
R. M. Burger.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 301-314. 15 fig, 5 ref.

Descriptors: *Filtration, *Chemical analysis, *Analytical methods, *Water analysis, *Sampling devices, *Measuring instruments, *Groundwater monitoring, *Groundwater pollution, *Monitoring wells, Groundwater management, Aquifers, Comparison studies, Field tests, Geohydrology, Sediment transport, New England, Groundwater.

A comparison was made of filtered and unfiltered groundwater samples from 20 monitoring wells from five different sites located in northern New England. A review of these data indicates that field filtration appears to substantially decrease the concentrations of the chemical parameters analyzed. The effect of field filtration on the chemical data also appears directly related to the monitoring well geology. Those wells situated in fine-grained silts and clays are impacted most by filtration, while bedrock wells show less of an impact from field filtration. Field filtration may mitigate the effect of monitoring wells placed in geologic materials not suitable for producing low turbidity and suspended solids samples. The use of field filtration may also provide consistent chemical data from wells that because of the geology or variations from sampling protocol have varying levels of sedimentation or turbidity over the course of a year. (See also W88-09283) (Author's abstract)
W88-09307

METHOD FOR CHARACTERIZING VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN SHALLOW SOILS,
Kennedy/Jenks/Chilton, Irvine, CA.
J. E. Norris, and D. K. Garfield.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 560-579. 4 fig, 2 tab.

Descriptors: *Soil gases, *Drilling, *Soil contamination, *Portable sampling devices, *Organic compounds, *Analytical methods, *Sampling devices, *Measuring instruments, *Chromatography, *Spectrophotometry, Detection limits, Path of pollutants, Chemical analysis, Data interpretation, Groundwater, Groundwater pollution, Groundwater monitoring, Perchloroethylene, Soil temperature, Soil water.

The traditional approach to the initial characterization of soils contaminated by volatile organic compounds (VOCs) has been the implementation of drilling and sampling programs with subsequent analysis of selected samples in the laboratory by gas chromatography (GC) or gas chromatography with mass spectrometry. This paper describes a method that can be used to cost-effectively screen shallow soils over a large area for VOC concentrations without the use of sophisticated laboratory and drilling equipment. The method was developed for use at a site where contamination of fine-grained soil. Analysis procedures are presented that describe the collection of a shallow soil push core and measurement of headspace concentrations of organic vapors emitted by the sample core when placed in a sealed container. The instruments used to measure the headspace organic vapor concentrations are a Century System Portable Organic Vapor Analyzer Model OVA-128 with an organic vapor detection range of 0.1 to 1,000 ppm volume in air (calibrated with methane), and a combustible gas indicator with a detection range of 0 to 100 percent gas by volume in air (calibrated with methane). Using the method, investigators may rapidly hand sample and analyze samples from a relatively large number of sampling locations. The method also includes determination of soil temperature and moisture content that may influence subsurface migration of VOCs and can be qualitatively used to interpret data. Laboratory analysis of selected samples by GC can be used to facilitate field data interpretation. The application of the method to a specific case history involving a perchloroethylene discharge beneath a building floor is also discussed. (See also W88-09283) (Author's abstract)
W88-09325

CHEMICAL ANALYSIS OF WATER: GENERAL PRINCIPLES AND TECHNIQUES,
Water Research Centre, Medmenham (England). Medmenham Lab.
For primary bibliographic entry see Field 7B.
W88-09355

CHEMICAL AND TOXICOLOGICAL ASPECTS OF SUPERFUND SITE CLEANUP,
ENVIRON Corp., Princeton, NJ.
For primary bibliographic entry see Field 5G.
W88-09376

SAMPLING AND ANALYSIS OF RAIN.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 7B.
W88-09387

SIMULATED PRECIPITATION REFERENCE MATERIALS: MEASUREMENT OF PH AND ACIDITY,
National Bureau of Standards, Washington, DC.
W. F. Koch, and G. Marinenko.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 10-17, 4 tab, 18 ref.

Descriptors: *Water analysis, *Chemical analysis, *Hydrogen ion concentration, *Acid rain, *Precipitation, Acidity, Monitoring, Pollutant identification, Physical properties.

The Center for Analytical Chemistry of the National Bureau of Standards has prepared and analyzed several series of simulated precipitation reference materials to be used as a means of intercalibrating atmospheric monitoring stations. In addition, research has shown serious errors in the measurement of pH and acidity determined in solutions of low-acidity and low-ionic strength. Contingent on further research pH measurements of acid rain should not be reported with greater confidence than 0.1 pH number. Titrations for total acidity should be performed to an inflection point or Gran plot endpoint and not to a fixed pH endpoint. Improved measurement protocols and reference standards are necessary to assure measurement comparability and consistency throughout the nation. (See also W88-09387) (Author's abstract)
W88-09389

PRACTICAL QUALITY CONTROL OF RAIN-WATER ANALYSES,
College of William and Mary, Williamsburg, VA. Dept. of Chemistry.
For primary bibliographic entry see Field 7C.
W88-09390

ANALYSIS OF RAIN BY ION CHROMATOGRAPHY,
Dionex Corp., Sunnyvale, CA.
A. W. Fitchett.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 29-40, 14 fig, 3 tab, 4 ref.

Descriptors: *Water analysis, *Rain, *Ion chromatography, *Chemical analysis, Pollutant identification, Ion exchange, Anions, Cations, Water sampling, Acid rain, Fluoride, Chloride, Phosphates, Nitrates, Sulfate, Sodium, Ammonium, Potassium, Calcium, Magnesium.

Ion chromatography (IC) incorporates ion exchange chromatography coupled to eluent suppression and electrical conductivity detection for the sequential elution and determination of anions or cations. In the area of rainwater analysis, IC offers the ability to determine anion and cation profiles at below parts per million levels in very small samples. IC is being used in several rain sampling networks such as Environmental Protec-

tion Agency, National Oceanic and Atmospheric Administration, and the U.S. Geological Survey. The parameters that are commonly measured by IC in rainwater are fluoride, chloride, phosphate, nitrate, sulfate, sodium, ammonium, potassium, calcium, and magnesium. This paper deals with all aspects of IC as it pertains to rainwater analysis and includes theory and instrumentation along with sample analysis. Details on the precision and accuracy of the technique and a comparison to other methodology are shown. (See also W88-09387) (Author's abstract)
W88-09391

ATMOSPHERIC SULFUR ANALYSIS USING RATEOMETRIC COLORIMETRY,
Houston Atlas, Inc., Houston, TX.
For primary bibliographic entry see Field 2B.
W88-09392

APPLICATIONS OF WITHIN-EVENT PRECIPITATION CHEMISTRY MEASUREMENTS,
Brookhaven National Lab., Upton, NY.
For primary bibliographic entry see Field 7A.
W88-09393

DATA COMPARABILITY: AN OBJECTIVE FOR PRECIPITATION CHEMISTRY MONITORING,
Southern Co. Services, Inc., Birmingham, AL.
For primary bibliographic entry see Field 7A.
W88-09394

SAMPLING, ANALYTICAL, AND QUALITY ASSURANCE PROTOCOLS FOR THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 7A.
W88-09395

UPDATING PROCESS IN PRECIPITATION QUALITY NETWORKS,
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 7A.
W88-09396

MANUAL OF GROUND-WATER QUALITY SAMPLING PROCEDURES,
Robert S. Kerr Environmental Research Lab., Ada, OK.
M. R. Scalf, J. F. McNabb, W. J. Dunlap, and R. L. Cosby.
National Water Well Association, Worthington, Ohio. 1981. 93 p, 32 fig, 2 tab, 23 ref, 2 append.

Descriptors: *Groundwater quality, *Monitoring, *Water sampling, Geohydrology, Water pollution control, Organic compounds, Inorganic compounds, Microbiological studies.

Recent environmental legislation has recognized the importance of groundwater quality protection and the stresses that man's activities, especially waste disposal, place on this vital national resource. To provide a realistic assessment of current and potential pollution problems and a rational basis for groundwater quality protection, it is necessary to collect representative samples from this remote and relatively inaccessible environment. This report presents some procedures currently utilized to sample groundwater and subsurface earth materials for microbial and inorganic and organic chemical parameters. In selecting a sampling procedure, a number of considerations are described based on the objective of the sampling program, characteristics of pollutants, nature of pollution source and geohydrology of the area. Various techniques for constructing sampling wells and for withdrawing samples are described with advantages and disadvantages of each method listed. For situations where samples of subsurface earth materials are required to assess groundwater quality threats adequately procedures are described for collecting, handling, and processing core samples. Finally sample preservation, sample records, and chain of custody procedures are discussed. The procedures described provide a basic capability for sampling subsurface environments. Additional research is needed, however, to further evaluate, improve and extend these capabilities, especially in sampling related to organic chemical parameters. (Author's abstract)
W88-09401

PRINCIPLES OF ENVIRONMENTAL SAMPLING.
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 7A.
W88-09415

OVERVIEW OF THE SAMPLING PROCESS,
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
For primary bibliographic entry see Field 7B.
W88-09416

DEFINING CONTROL SITES AND BLANK SAMPLE NEEDS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 7A.
W88-09417

ASSESSING AND CONTROLLING SAMPLE CONTAMINATION,
Radian Corp., Austin, TX.
D. L. Lewis.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 119-144, 4 fig, 3 tab, 22 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Sample preparation, *Sample preservation, Contamination, Blanks, Statistical analysis, Control charts, Errors.

Sample contamination may occur during collection, transport and storage, preparation, and analysis. Some examples are groundwater samples contaminated with chemicals and fuels used in well drilling, nitrate contamination of samples filtered through nitrate-cleaned filters, contaminated reagents, and rainfall samples contaminated by dry deposition. Containers are another major source of contamination. Some plastic containers have significant levels of leachable trace elements. Glass containers used in organic analysis should be acid washed, rinsed with organic-free water, and heated in a muffle furnace. Cross-contamination of samples stored near each other is common. Even single-step analytical procedures offer opportunity for contamination, namely cleanup cartridges, filtration units, glassware, reagents, syringes, and pipette tips. Interferences are additive (change intercept but not slope of calibration curve) and multiplicative (change slope but not intercept of calibration curve). Dilution can cause interference in groundwater sampling. Blanks are useful in controlling sample contamination errors. Types of blanks include system blank (instrument blank), solvent blank (calibration blank), reagent blank (method blank), matched-matrix blank, sampling media blank (trip blank), and equipment blank. Shewhart control charts are effective in ongoing control or in retrospective assessment of blank measurements. Control charts for individual measurements, or X charts, are most appropriate for blanks. However, other systems may be applicable under certain circumstances. These include the X bar chart (control chart for means), R chart (control chart for ranges), and c chart (a control chart for nonconformities). (Cassar-PTT)
W88-09418

STORAGE AND PRESERVATION OF ENVIRONMENTAL SAMPLES,
Oak Ridge National Lab., TN.
M. P. Maskarinec, and R. L. Moody.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 145-155, 2 tab, 3 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Sample preservation, Sample preparation, Organic compounds, Volatility, Solvents, Storage, Errors.

Preanalytical holding times for volatile organic compounds and explosives in water and soil were established for a variety of storage conditions. Factors considered were sample matrix (soil or liquid), level of contamination, storage conditions, factors governing loss of sample integrity (biological action, chemical action, volatilization, and photodegradation), time intervals, and concentration levels. Results showed that error was minimized by fortifying water samples before aliquots were taken. For soil samples, a soil aliquot was combined with a portion of fortified water. It was also discovered that vials should be filled with no headspace and stored at low temperature. (See also W88-09415) (Cassar-PTT)
W88-09419

EVALUATING AND PRESENTING QUALITY ASSURANCE SAMPLING DATA,
Research Triangle Inst., Research Triangle Park, NC.
F. Smith, S. Kulkarni, L. E. Myers, and M. J. Messner.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 157-168, 11 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Quality control, Errors, Precision.

This paper concerns (1) procedures for evaluating quality assurance information for sampling and (2) techniques for presenting the resulting data in final reports. The five data quality indicators are sensitive to the manner in which sampling is carried out. These include precision, bias, representativeness, completeness, and comparability. Requirements for reporting each of these are given. Total variability of monitoring data is treated in terms of three sources of error: sampling design, sampling implementation, and analysis. (See also W88-09415) (Cassar-PTT)
W88-09420

SAMPLING WATERS: THE IMPACT OF SAMPLE VARIABILITY ON PLANNING AND CONFIDENCE LEVELS,
Dow Chemical U.S.A., Midland, MI. Mammalian and Environmental Toxicology.
U. M. Cowgill.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 171-189, 9 tab, 27 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, Contamination, Blanks, Ice, Snow, Dew, Stratification, Thermal stratification, Chemical stratification, Errors, Variability, Planning, Experimental design, Statistical analysis.

Problems associated with sampling include contamination from sampling equipment, sorption and leaching of contaminants by sampling tool materials, improper choice of replication number, inadequate frequency of sampling, and lack of proper blanks. Problems also arise from the type of water body being studied (lakes, rivers, streams, oceans, or aquifers) or the physical state of the sample (snow, ice, rain, fog, or dew). The stratum from which the sample is collected is of utmost importance. For example, lakes deeper than 5 m are usually chemically and/or thermally stratified. A rapidly flowing river of considerable depth may exhibit chemical stratification without thermal stratification. Ice and snow composition varies vertically but not usually horizontally because of entrapped plankton or atmospheric deposition. The elements Ca, Si, Al, P, Ba, Sr, and Mn are concentrated in ice in reference to the surface centimeter of water, but this relationship is not the case for Fe and Ti. The chemical composition of snow changes considerably upon standing. Sampling of fresh snowfall would reflect the atmospheric conditions during the snowfall. The composition of rainfall is also highly variable with time. Sampling of a three-hour rainfall over Pittsburgh, Pennsylva-

nia, showed the following initial and final parameters: pH 1.2-5.1; Cl, 10.1-4.2 mg/liter; sulfate, 29.3-7.6 mg/liter; boron, 0.18-0.08 mg/liter; Na, 5.8-2.4 mg/liter; K, 0.61-0.25 mg/liter; Mg, 2.75-0.38 mg/liter; Ca, 3.05-0.25 mg/liter; and nitrogen, 4.7-0.86 mg/liter. Analysis of dew and fog samples shows large coefficients of variation with time, strata, and horizontal spacing. Ocean water sampling has problems similar to that of stratified lakes, with the near-shore waters showing great variation in chemical composition. (See also W88-09415) (Cassar-PTT)
W88-09421

ASSESSMENT OF MEASUREMENT UNCERTAINTY: DESIGNS FOR TWO HETEROSCEDASTIC ERROR COMPONENTS,
National Bureau of Standards (NEL), Gaithersburg, MD.
W. S. Liggett.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 191-208, 1 tab, 11 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Experimental design, *Statistical analysis, *Quality control, *Errors, Standard deviation, Model studies.

Specification of quality assurance samples is discussed for sampling and measurement error having two independent, heteroscedastic components. Each component is heteroscedastic because its standard deviation depends on concentration. This error model is appropriate for environmental studies in which the samples are measured in several batches and the sample concentrations vary widely. The design considered specifies that a duplicate of a routine sample and two reference samples be included in each batch. Some batches have reference samples with the same concentration; others do not. The adequacy of this design depends on the number of batches, on the relative sizes of the within-batch and among-batch error components, and on the concentrations in both the samples of interest and in the quality assurance samples. (See also W88-09415) (Author's abstract)
W88-09422

MODERN SAMPLING EQUIPMENT: DESIGN AND APPLICATION,
Isco, Inc., Lincoln, NE.
L. H. Newburn.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 209-219, 1 fig, 14 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Measuring instruments, *Wastewater analysis.

Important, desirable characteristics of automatic wastewater samplers and guidelines for their correct application are presented. The ideal sampler should be watertight, explosion-proof, thermally insulated, field repairable, operable on both ac and dc electrical sources, less than 40 lb, usable in a manhole, capable of sampling at intervals of 1 min to at least 4 hr, capable of either flow-proportional or timed-interval use, convertible from sequential to composite sampling, and capable of multiplexing several samples into one bottle. It should have a 0.25-inch ID suction line with a weighted strainer, a minimum lift of 20 ft, a system for locking, and no metal parts in contact with the sample. The sampler should operate at temperatures from -30 to 50 C and purge the sample line before and after sampling. Representative sample collection also depends on the user's knowledge of sampling requirements and the equipment. Studies on positioning of the sample intake(s) indicate that single-point intakes are not satisfactory. A fixed intake located at 60% of the stream depth in an area of maximum turbulence and having an intake velocity equal to or greater than the average wastewater velocity at the sample point provides the most representative sample. The strainer should not be placed on the bottom of the stream lest the sample be artificially enriched in sediments. (See also W88-09415) (Cassar-PTT)
W88-09423

PRESERVATION TECHNIQUES FOR ORGANIC AND INORGANIC COMPOUNDS IN WATER SAMPLES,
Enesco, Inc., Arvada, CO.
J. Parr, M. Bollinger, O. Callaway, and K. Carlberg.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 221-230, 1 tab, 8 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Inorganic compounds, *Sample preservation, *Organic compounds, Volatility, Adsorption, Absorption.

Preservation techniques are used to minimize changes between collection and analysis. Physical changes such as volatilization, adsorption, diffusion, and precipitation, and chemical changes such as photochemical and microbiological degradation are minimized by proper preservation. The preservation process encompasses both field and laboratory activities and includes techniques such as chemical addition, temperature control, and the choice of sampling containers. The lack of consistent, validated guidelines for preservation techniques and holding times for similar sample types has resulted in uncertainty among those who routinely collect and analyze samples. These numerous and often conflicting guidelines affect data quality, laboratory operations, and the cost of analytical determinations. (See also W88-09415) (Author's abstract)
W88-09424

SAMPLING GROUNDWATER MONITORING WELLS: SPECIAL QUALITY ASSURANCE AND QUALITY CONTROL CONSIDERATIONS,
IT Corp., Austin, TX.
R. T. Kent, and K. E. Payne.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 231-246, 6 fig, 2 tab, 20 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Groundwater management, *Water quality control, *Monitoring, *Observation wells, *Groundwater, *Wells, *Quality control, Geohydrology, Water analysis, Aquifers, Sample preservation.

Quality assurance and quality control for sampling groundwater monitoring wells begins by defining the hydrologic and geochemical characteristics of the aquifer. Variations in lithology, permeability, and geochemistry of naturally occurring waters within the aquifer should be identified and taken into account when designing and sampling the groundwater monitoring wells, and when drawing conclusions based on the analytical data of the collected sample. Any conclusions should also take into account the limitations of the accuracy of the analytical test method used to quantify the monitored species. Other factors to take into account are sources of sample alteration that include the degree of well purging during sampling, contamination or alteration of the sample by the sampling device, and absorption of air contaminants by the sample during collection. (See also W88-09415) (Author's abstract)
W88-09425

TECHNIQUES FOR SAMPLING SURFACE AND INDUSTRIAL WATERS: SPECIAL CONSIDERATIONS AND CHOICES,
BCM Converse, Inc., Mobile, AL.
J. E. Norris.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 247-253, 3 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Streams, *Industrial wastewater, *Wastewater analysis, *Biological samples, Sediment sampler, Fish, Toxicity, Streams.

This paper describes specific aspects of sampling of industrial wastewaters and receiving streams. Sediment sampling can be accomplished by bottom grab sampling or core sampling. If finely divided particles are needed in the sample, the core sampler is more suitable. For collecting fish, the services of a professional fisherman are invaluable, especially if only one or two particular species must be obtained. Electric shockers and slat boxes offer some advantages over nets and trot lines. The whole fish should be frozen. If aluminum foil is used to wrap the fish, it should be thoroughly cleaned with methylene chloride to remove the organic slip agents. High-speed blenders should not be used for homogenization of fish tissue because lipids tend to separate, producing a nonhomogenous sample. Industrial wastewater sampling can be done with grab sampling, composite sampling, and continual sampling. The grab sample is least representative. However, it is specified for sampling for chloroform and other chlorinated organics. Nevertheless, upstream sampling, which is not required to be done by grab sampling, may be done with the automatic compositing sampler. For receiving water sampling, fixed (continual or composite) samplers are usually prohibited in navigable waters. Therefore, grab sampling from a boat is generally used. The spatial gradient technique is good for choosing sampling locations for chemical constituent analysis as long as possible interfering factors (mixing zones, plumes,) tidal effects, etc. are considered. (See also W88-09415) (Cassar-PTT)
W88-09426

GROUNDWATER SAMPLING,
Satterthwaite Associates, Inc., West Chester, PA.
J. S. Smith, D. P. Steel, M. J. Malley, and M. A. Bryant.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 255-260, 1 tab, 4 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Sample preservation, *Groundwater, Anaerobic conditions, Purge-volume test.

The sampling of groundwater has numerous variables that affect the analytical results. These variables include the purging volume, the time interval between purging and sampling the sample treatment (filtration), the sample storage (oxidation conditions), the purging methodology, and the placement of the purging device relative to placement of the sampling device in the well. Groundwater samples cannot contain any particulate matter and must be protected from air at all times if the sample is to be truly representative. Since groundwater is nearly oxygen-free, the dissolved ions tend to be in their most reduced state. The main considerations in proper groundwater sampling are use of the purge-volume test, consistent sampling protocol, anaerobic sampling and handling conditions, and sample filtration. (See also W88-09415) (Cassar-PTT)
W88-09427

COPING WITH SAMPLING VARIABILITY IN BIOTA; PERCENTILES AND OTHER STRATEGIES,
Food and Drug Administration, Washington, DC. Center for Food Safety and Applied Nutrition.
R. Albert, and W. Horwitz.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 337-353, 3 tab, 4 ref, append.

Descriptors: *Pollutant identification, *Sampling, *Bioaccumulation, *Fish, *Biological samples, Aquatic life, Statistical analysis, Gaussian distribution, Variability.

Problems in obtaining representative samples of biota are related to the large variability encountered and the corresponding uncertainties in the estimates. Also, the distribution of values (for example, mercury concentrations in fish) may not be normal, that is bell-shaped, or of Gaussian distribution. To reduce the uncertainties, several strategies may be applied: increasing the number of units sampled or breaking down the population into distinct subgroups. The distribution of the individual values should be indicated. For biota, the various percentile points can be reported along with the confidence limits derived from the binomial

distribution. The final results of sampling biota may well be an average plus key percentiles of the distribution values. (See also W88-09415) (Cassar-PTT)
W88-09428

COMPOSITE SAMPLING FOR ENVIRONMENTAL MONITORING,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 7A.
W88-09429

CONSIDERATIONS FOR PRESERVING BIOTIC SAMPLES,
New York State Agricultural Experiment Station, Geneva. Analytical Labs.
T. D. Spittler, and J. B. Bourke.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 375-381, 6 ref.

Descriptors: *Pollutant identification, *Sampling, *Organic compounds, *Sample preparation, *Biological samples, *Sample preservation, Aquatic life.

Biological samples are notoriously susceptible to alterations in composition due to decomposition. Even inorganic compounds can be altered by further reactions. Although this alteration may not affect elemental inorganic determinations, anion determinations (nitrogen, phosphorus, and sulfur compounds) may be seriously changed by oxidation-reduction reactions. Proper preservation methods can minimize these alterations. These may include freezing, pH adjustments, and addition of organic solvents, especially if the solvent will be used later in the analytical procedure. Sometimes spiked samples are stored in the freezer with the collected samples to plot any decomposition or disappearance of an organic analyte before analysis. Glass containers with inert seals or cap liners are suitable for most biological samples, although analytes have been reported to decompose or absorb onto a glass surface. The newer polyethylene and polypropylene containers show little interference with analytical methods. If a sample is extracted and stored pending analysis, its stability in the solvent should be ascertained. Ethyl carbamate is stable in methylene chloride but not in 10% ethanol/water or ethyl acetate. Another problem is condensation of moisture on cold samples being processed. (See also W88-09415) (Cassar-PTT)
W88-09430

SAMPLING AND VARIABILITY IN SOILS AND SOLID WASTES,
E. K. Triegel.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 385-394, 13 ref.

Descriptors: *Pollutant identification, *Sampling, *Soil analysis, *Solid wastes, Wastes, Landfills, Sludge, Variability.

Solids, sludges, and liquid wastes frequently exhibit wide variability in their properties and chemical compositions. Variations in the sampling program results may be a consequence of the inherent properties of the materials or an artifact of the sampling process itself. An example is evaluation of soil at a proposed landfill where the difficulty of collecting rocky portions may result in an undersampling of that horizon. Goals of the sampling program must be determined. For example, if the goal of soil sampling at a former waste lagoon is to determine how much contaminated soil must be removed, sampling at 1-ft intervals is satisfactory, considering the scale of the excavation equipment. The most critical or sensitive parameters must be chosen to narrow the sampling program to a manageable number of measurements. The most suitable sampling plan should consider the statistical characteristics of the population to be sampled and the level of sampling effort needed to adequately characterize the problem. Outlier values, though infrequent, must also be considered; these could include vertical fractures in soil or small volumes of concentrated toxic materials in a larger mass. The sampling method is a function of the goal, parameter variability, and the impact of the variation on the conclusions. Interpretation of the data may involve statistical methods to quantify variations and relationships among variables. Confidence in the conclusions may be increased by more thorough characterization of variations, by the use of alternate means of data evaluation, or by the use of backup systems such as continuous monitoring. (See also W88-09415) (Cassar-PTT)
W88-09431

RELATIONS OF SAMPLING DESIGN TO ANALYTICAL PRECISION ESTIMATES,
Radian Corp., Austin, TX.
L. J. Holcombe.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 395-408, 2 fig, 4 tab, 7 ref.

Descriptors: *Pollutant identification, *Sampling, *Precision, *Chemical analysis, *Network design, *Statistical analysis, *Wastes, Ash, Coal ash, Powerplants, Estimating.

The frequency of sampling or the spatial distribution of samples required to obtain a representative sample depends on the variability of the waste composition and the precision of the required waste analysis (the presence of a regulated pollutant near the limits of concern requires greater precision than pollutants at very low levels). A study conducted at a coal-fired powerplant is described. To achieve at least 50% precision in a 30-day average coal ash composition, the optimal sampling design requires seven samples, each analyzed twice, for a total of 14 analyses over the 30-day period. Formulas are given for assisting in sampling design. (See also W88-09415) (Cassar-PTT)
W88-09432

SAMPLING AND ANALYSIS OF HAZARDOUS AND INDUSTRIAL WASTES: SPECIAL QUALITY ASSURANCE AND QUALITY CONTROL CONSIDERATIONS,
University of Wyoming Research Corp., Laramie. Western Research Inst.
L. P. Jackson.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 415-423.

Descriptors: *Pollutant identification, *Sampling, *Industrial wastes, *Chemical analysis, *Hazardous materials, *Wastes, *Quality control, Regulations.

The design and conduct of sampling operations for industrial and hazardous wastes must consider the following problems: rapid introduction of new regulations; varying requirements of the regulatory programs among local, state, and federal agencies; and technical limitations in the methods required to sample and analyze the wastes. These problems ar compounded by the lack of guidance and assistance available from the agencies. The institutional problems can be minimized if the private sector and the regulatory community reduce the adversarial nature of their relationship. Trade associations should assemble the methods used for sampling and analysis and submit them to EPA for review. Alternatively, this can be done through a national organization such as the American Society for Testing Materials. In cases where the EPA has not formally accepted a submitted method or there is desagreement about the validity of a regulation, the private sector party can submit further data to substantiate or challenge a method. Quality assurance and control programs must be modified as new types of samples and analytes are added to the list of regulated substances. Some possible changes are related to more efficient use of samples collected and spiking procedures to study degradation during the sample holding period. Other technical problems caused by the increasingly low analyte concentrations are interferences and overload of chromatographic equipment by an occasional concentrated sample. The screening tests allowed under the regulations to establish that specific analytes are not present at regulator threshold levels should be used more widely as a cost saving measure. (See also W88-09415) (Cassar-PTT)
W88-09433

METHODS OF RECOVERING VIRUSES FROM AQUATIC SEDIMENTS,
Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
V. C. Rao, and G. Bitton.
IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 21 IN:-36, 2 fig, 7 tab, 22 ref.

Descriptors: *Viruses, *Aquatic sediments, *Virus recovery, *Water analysis, *Laboratory methods, Hydrogen ion concentration, Marine sediments, Chemical treatment, Beef extract, Sodium nitrate, Water quality control, Comparison studies, Standards, Quality control, Public health, Estuaries.

Many enteric viruses adsorb to marine sediments at ambient pH of seawater with greater than 99% efficiency, perhaps due to high ionic concentration, while virus adsorption to freshwater sediments is slightly lower. Several methods have recently been developed for recovering viruses from sediments. Most of these methods pertain to virus recovery from estuarine sediments. The efficiency of any viral recovery technique involving sediments depends primarily on the initial elution of virus from sediments. The efficacy of many of the eluents tested varied with the type of sediment used. Sediment composition (clay, sand, silt, and organic matter) and ionic composition of the water may influence virus elution from sediments. From the limited data available, beef extract supplemented with a chaotrope such as sodium nitrate at pH 5.5 appears to recover virus effectively from both freshwater and estuarine sediments of varying compositions. Methods used for concentrating poliovirus from sediment eluates appear to be reasonably efficient, but their efficiency must be evaluated with regard to the recovery of rotavirus and hepatitis A virus from a variety of sediments. Further evaluations of some of the currently available methods should be conducted using well-characterized sediments in a round-robin study so as to provide a standard method for virus detection in sediments. (See also W88-09463) (Lantz-PTT)
W88-09465

METHODS FOR CONCENTRATION AND RECOVERY OF VIRUSES FROM WASTEWATER SLUDGES,
Florida Univ., Gainesville. Dept. of Microbiology and Cell Science.
S. R. Farrah.
IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 91-100, 1 fig, 7 tab, 42 ref.

Descriptors: *Wastewater treatment, *Viruses, *Virus recovery, *Laboratory methods, *Sludge, Hepatitis, Public health, Shaking, Blending, Sonication, Stirring, Performance evaluation, Flocculation, Adsorption, Ultracentrifugation, Hydroextraction.

Procedures for recovering viruses from sludges (shaking, blending, sonication, stirring, flocculation, adsorption, ultracentrifugation, hydroextraction, two-phase concentration, and lyphogel) are effective in recovering indigenous viruses in wastewater sludges. These procedures can be used to determine the fate of sludge-associated viruses during wastewater treatment and after sludge disposal. However, none of the procedures was evaluated for recovering rotavirus and hepatitis A virus from sludge. Improvements in procedures should be capable of: (1) recovering viruses from different sludge types, since sludge type may influence recovery of viruses; (2) producing a final sample that is small enough to permit economical assay of the entire sample; and (3) producing a final sample that is free of bacterial and fungal contaminants and not toxic to cell cultures. Specialized equipment or highly trained personnel should not be required. (See also W88-09463) (Lantz-PTT)
W88-09469

METHODS OF ENTEROVIRUS RECOVERY FROM DIFFERENT TYPES OF SOILS,
Epidemiology Research Center, Tampa, FL.
F. M. Wellings.

IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 129-139, 2 fig, 1 tab, 51 ref.

Descriptors: *Enteroviruses, *Viruses, *Wastewater treatment, *Laboratory methods, *Wastewater analysis, *Standards, *Virus recovery, *Microbiological studies, Elution, Concentration, Toxicity, Bioassays, Economic aspects.

The recovery of virus from different types of soils entails the elution of virus from the soil particles with direct viral assay of the eluate or concentration of the eluate before assay. Problems associated with the currently used techniques include large volumes for viral assay, persistent contamination, and toxicity of the concentrates. At present, there is neither a standard technique nor a tentative standard technique for the recovery of virus from different types of soils. Because of this, there is no basis for a comparative evaluation data. The initial round-robin testing of the two methods (Berg and Berman vs. Goyal) indicated that each had its unique advantages and disadvantages. Perhaps within the next year or two, improvements in either or both of the methods will be forthcoming and an efficient standard method will be available. (See also W88-09463) (Lantz-PTT)
W88-09472

IN-SITU ANALYSIS OF GASOLINE-CONTAMINATED GROUND WATER,
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
W. Chudyk, K. Pohlig, N. Rico, J. Kenny, and G. Jarvis.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 181-186, 2 fig, 5 ref.

Descriptors: *Groundwater pollution, *Pollutant identification, *Lasers, *Remote sensing, *Storage tanks, Gasoline, Leakage, Water pollution prevention, Organic compounds, Oil spills, Aromatic compounds, Benzenes, Monitoring.

In order to determine the extent of existing contamination by leaking tanks or spills, a means of analysis which is rapid, accurate, and inexpensive is required. Because of its advantages over conventional sampling and analysis methods, in-situ analysis of groundwater is becoming an attractive alternative to conventional sampling and analysis methods. The prototype instrument recently developed uses remote laser-induced fluorescence (RLIF) to measure aromatic organics in-situ. Since aromatic organics such as benzene, toluene, and xylenes are a significant fraction of gasoline, RLIF is a useful tool in monitoring gasoline contamination of groundwater. Results of laboratory and field analyses are presented, with a discussion of the advantages and limitations of RLIF. Advantages include elimination of sample handling and chain-of-custody documentation, rapid determination of results, and relatively low cost. Limitations at this time include a lack of distinction between similar aromatic contaminants, which is the focus of further research. Quality control and quality assurance concerns are also discussed, which include confirmatory tests using gas chromatographic methods. (See also W88-09477) (Author's abstract)
W88-09489

APPLICATION OF THE SOIL-GAS SURVEY TO UNDERGROUND STORAGE TANK MONITORING AND LEAK DETECTION,
Hydrosystems, Inc., Falls Church, VA.
P. Ferre, and L. R. Silka.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 187-205, 11 fig, 1 tab, 2 ref.

Descriptors: *Groundwater pollution, *Pollutant identification, *Organic compounds, *Soil contamination, *Storage tanks, Leakage, Leachates, Computer models, Soil surveys, Path of pollutants, Monitoring, Model studies.

Soil-gas surveys are becoming widely accepted as a tool for the preliminary determination of the extent of soil and groundwater contamination by volatile organic compounds (VOCs). These surveys are being applied to the investigation of a variety of sites including leaking above and underground tanks and pipelines, surface spills, landfills, and impoundments. The soil-gas survey generally involves the collection of soil gas along a grid of stations and the analysis of that gas for the presence of VOCs. Since soil contamination by liquid VOCs typically causes vapor concentrations in soil gas in the immediate vicinity of the source to increase over several thousand to tens of thousand parts per million, outward diffusion of the VOC vapor through soil pores results in easily detectable concentrations of the VOC in soil gas up to tens of meters away from the source. A two-dimensional, finite difference computer model has been developed to simulate the movement of VOCs through unsaturated soils. This model has been modified to specifically model the release of VOCs from an underground tank. Variables including organic content, soil moisture content, and diffusion coefficients can be varied for both the backfill and host material. The objectives of this model were to determine the applicability of a soil gas survey to monitoring and leak detection for an underground tank. The development of an appropriate computer model and the results of modeling underground tank leaks are discussed. The use of a vapor monitoring system provides early warning of a leak before a significant amount of chemical is released. The installed cost of a three-detector vapor monitoring system is about $2,000 to $3,000. (See also W88-09477) (Geiger-PTT)
W88-09490

BIOLOGICAL TRACERS OF POLLUTION PLUMES FROM SEPTIC SYSTEMS,
Wisconsin Univ.-Madison. Water Resources Center.
B. J. Alhajjar, J. M. Harkin, D. O. Cliver, and S. L. Stramer.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 247-277, 8 fig, 3 tab, 60 ref. Bureau of Reclamation Contract No. 14-34-0001-0257.

Descriptors: *Indicators, *Tracers, *Coliforms, Viruses, Streptococcus, *Bioindicators, *Path of pollutants, *Groundwater pollution, Models, Septic tanks, Pollutant identification, Human diseases, Chlorides, Conductivity, Water table fluctuations, Septic wastewater.

Chloride (Cl) and electrical conductivity (EC) as tracers of chemicals and indicator bacteria - total coliforms (TC), fecal coliforms (FC), and fecal streptococci (FS) - were determined for 7 months in septic tank effluent and ground water samples collected downgradient from 17 new or replacement septic systems. Indicator bacteria were also determined occasionally in ground water samples from wells near the systems for a continuing period of 2 years. Following 5 years of system operation a last round of analyses was conducted. Water table fluctuations in the vicinity of the septic systems were monitored for 2 years. As a model for viruses, vaccine poliovirus in feces from babies who had received the trivalent Sabin oral poliovirus vaccine was introduced into one septic system as a single dose by flushing down the toilet. Effluent and ground water were assayed for poliovirus over a period of 6 months. The data were evaluated statistically and a contaminant transport model was tested to simulate ground water contamination by the tracers of pathogens. No tracer bacteria reached ground water from any of the 17 septic systems. Presumably, the bacteria were removed by the soil under the seepage bed; mean transport was < 1 count/100 ml for each bacterial type, in keeping with U.S. codes of public health drinking water regulations. Poliovirus entered and spread in groundwater from the one septic system tested, even though this was functioning properly. Of 3.3 times 10 to the 8th power counts of poliovirus inoculated into the septic tank, a mean of 70 counts/100 ml escaped from the tank with the effluent and an overall mean of 62 counts/100 ml were transported to groundwater. Septic systems had little influence on water table fluctuations in their vicinity compared to the seasonal climatic factors. (See also W88-09477) (Author's abstract)
W88-09493

INTERPRETATION OF EM DATA THROUGH GEOELECTRIC MODELING WITH APPLICATION TO A LANDFILL IN SOUTHEASTERN NEW HAMPSHIRE,
Normandeau Engineers, Inc., Concord, NH
S. B. Shope.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 593-626, 12 fig, 4 tab, 14 ref, append.

Descriptors: *Landfills, *Groundwater pollution, *Electromagnetic waves, *Geophysics, *Magnetic studies, *Electromagnetic studies, *Path of pollutants, *Pollutant identification, Core logging, Models, Conductivity, New Hampshire, Model studies, Soil contamination, Aquifer characteristics, Geohydrology.

The glaciomarine environment of southeastern New Hampshire presents a unique problem to interpretation of electromagnetic (EM) data. Contribution from an electrically conductive marine clay unit dominates the geoelectric section. An innovative approach to modeling the section allows for response due to the clay layer to be differentiated from response due to overlying groundwater contamination. This is important in deciding if a reading is indicative of contaminated conditions. Soil boring logs indicate a five-layer standard geoelectric section. Using published ranges of layer conductivities, initial estimates of layer responses for uncontaminated conditions reveal that two layers are responsible for approximately 90% of the total instrument response. The geoelectric model developed in this study incorporates two equations and two unknowns. The two unknowns, the conductivities of the saturated clay layer and an overlying saturated sand layer, are uniquely solved. Due to the uniqueness of the results, the model is limited by deviations from a layered-earth assumption and by resistive background conditions. The model is capable of determining the layer conductivities where apparent terrain conductivity readings are at least 1.6 times background values. Conductivities of the saturated sand layer generally agree with those estimated through Archives Law. The calculated average conductivity value for the saturated clay is 21 mS/m (48 ohm-m). A design plot based on the geoelectric model indicates that for this site, field readings above 10 mS/m (HDM) or 8 mS/m (VDM) are indicative of contaminated conditions. (See also W88-09477) (Author's abstract)
W88-09510

USE OF PORTABLE PHOTOIONIZATION METERS TO ASSESS THE LATERAL AND VERTICAL DISTRIBUTION OF CONTAMINANTS AT HAZARDOUS WASTE FACILITIES: A CASE STUDY,
Dunn Geoscience Corp., Albany, NY.
P. W. Hare.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 627-648, 11 fig, 5 tab, 7 ref.

Descriptors: *Path of pollutants, *Hazardous wastes, *Waste dumps, *Photoionization meters, *Pollutant identification, Organic compounds, Groundwater pollution, Air pollution, Soil contamination, Test wells, Water quality, Monitoring, Case studies, Spatial distribution, Delaware.

Portable photoionization meters are often used during investigation of hazardous waste facilities for air monitoring related to health and safety issues. However, these instruments can prove extremely useful in determining both the lateral and vertical distribution of volatile organic contaminants, determining optimum screen intervals for

groundwater monitoring wells, selection of samples for subsequent laboratory analysis, and assisting in the quality control review of laboratory results. A case study of a hazardous waste disposal site in Delaware is used as an illustration. A two-step field procedure is advanced for screening split spoon samples: the first step involves direct readings on split spoon samples while the second step involves headspace readings on jarred portions of split spoon samples. Problems identified with active heating of headspace samples resulted in use of a procedure involving passive heating to room temperature for several hours which produced consistent results with lower background readings. In the case study presented, headspace readings are found to correlate with groundwater chemistry as determined by laboratory analysis. Groundwater contamination was documented for monitoring wells screened in intervals which produced elevated headspace readings while no contamination was detected for screened intervals producing headspace readings in the background range. Headspace readings also correlate with soil chemistry. However, headspace results were useful in identifying laboratory problems on soil samples associated with acetone. Finally, a comparison of direct field readings to headspace readings shows that the headspace method has greater resolution. Field readings can miss contamination at low, but significant levels. (See also W88-09477) (Author's abstract)
W88-09511

LEVANT INVESTIGATION: USING RADIOCARBON DATING TO DETERMINE THE SOURCE OF METHANE GAS CONTAMINATION,
New York State Dept. of Environmental Conservation, Albany.
For primary bibliographic entry see Field 5B.
W88-09512

HIGH FREQUENCY PERCUSSION-DRIVEN MICRO-WELLS IMPROVE EFFICIENCY OF CONTAMINANT PLUME DEFINITION,
Pine and Swallow Associates, Acton, MA.
For primary bibliographic entry see Field 7A.
W88-09518

INTERCALIBRATION EXERCISE FOR TRACE METALS IN MARINE SEDIMENTS,
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
D. H. Loring, and R. T. T. Rantala.
Marine Chemistry MRCHBD, Vol. 24, No. 1, p 13-28, 1988. 3 fig, 2 tab, 15 ref.

Descriptors: *Laboratory methods, *Chemical analysis, *Trace metals, *Marine sediments, *Calibrations, *Statistical analysis, Atomic absorption spectroscopy, Heavy metals, Cadmium, Chromium, Mercury, Standards, Aluminum, Copper, Iron, Manganese, Performance evaluation, Nickel, Lead, Titanium, Zinc.

This paper describes the results of a recent International Council for the Exploration of the Sea (ICES) intercalibration exercise. (1/TM/MS) compared various dissolution/extraction procedures used in the determination of major and trace metals in marine sediments to examined and improve the reliability and comparability of such metal analyses within ICES member countries. Forty participants determined some, or all, of the Al, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Ti and Zn concentrations in replicate digests of three sediment samples using HF+ aqua regia, aqua regia, 1 M HCl and 25% v/v acetic acid (HOAc) dissolution/extraction procedures and a separate procedure for Hg. HF+ aqua regia dissolution proved to be the most effective method for removing the total trace metal concentrations from the samples, and 25% v/v HOAc was shown to be a weaker acid attack than 1 M HCl. Data analyses show that the intra-laboratory variations were acceptable for most replicate metal determinations except for Hg. The overall inter-laboratory agreements were, however, unacceptable for total Cd, Cr, Hg and Ni concentrations in all three samples. Acceptable agreements were obtained only for Al, Fe, Mn and Zn in all samples, Cu in only two samples and Pb in only one sample. Most inter-laboratory agreements were also unacceptable for most of the metals determined after dissolution/extraction by aqua regia, 1 M HCl, or 25% v/v HOAc. The use of inappropriate atomic absorption spectrophotometry procedures and the non-use, or misuse, of reference materials appear to be the main reasons for some poor individual laboratory performances and for the poor inter-laboratory comparability for many metals. (Author's abstract)
W88-09559

MICRODETERMINATION OF VANADIUM IN WATER SAMPLES,
Naval Chemical and Metallurgical Lab., Bombay (India).
A. K. Shrivastava.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 1+2, p 1-9, October 1986. 5 tab, 22 ref.

Descriptors: *Vanadium, *Water analysis, *Heavy metals, *Water pollution, *Pollutant identification, Coprecipitation, Hydrogen ion concentration, Standards.

Vanadium has been recognized as a potentially dangerous pollutant in the class of lead, cadmium and mercury. It plays a vital role in enzyme reactions and nitrogen fixation. The determination method proposed here incorporates preconcentration of vanadium in water samples by its coprecipitation on ferric hydroxide at pH 8.0-9.6 which is then redissolved in sulfuric acid. This is followed by extraction with N-phenylbenzohydroxamine acid. Standard water samples, obtained from the U.S. Environmental Protection Agency, Environmental Support Laboratory, were analyzed by the proposed method and yielded results in excellent agreement with the certified values. (Author's abstract)
W88-09565

USE OF POLLUTANT AND BIOGENIC MARKERS AS SOURCE DISCRIMINANTS OF ORGANIC INPUTS TO ESTUARINE SEDIMENTS,
Institute for Marine Environmental Research, Plymouth (England).
For primary bibliographic entry see Field 5B.
W88-09566

DEVELOPMENTS IN THE SPECIATION AND DETERMINATION OF ALKYLMETALS (SN, PB) USING VOLATILIZATION TECHNIQUES AND CHROMATOGRAPHY-ATOMIC ABSORPTION SPECTROSCOPY,
New Hampshire Univ., Durham. Dept. of Chemistry.
O. F. X. Donard, L. Randall, S. Rapsomanikis, and J. H. Weber.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 1+2, p 55-67, October 1986. 2 fig, 3 tab, 31 ref.

Descriptors: *Pollutant identification, *Chemical analysis, *Heavy metals, *Alkylmetals, *Water analysis, *Chemical analysis, *Path of pollutants, *Water pollution, *Atomic absorption spectroscopy, *Chromatography, Volatility, Alkyltins, Alkylleads, Optimization, Performance evaluation, Tin, Lead, Speciation, Toxicity.

The behavior and fate of heavy metals in the environment is related to the reactivity of their chemical species in the water phase. Further, alkylmetals are more toxic than their free ionic counterparts and usually their toxicity and impact on the biota increase with the size of the alkylgroup. However, their low concentrations in the environment (nanogram to picogram/L) require highly sensitive techniques. We have developed several sensitive methods for the speciation and determination of alkyltins and alkylleads from aqueous samples. All are derived from volatilization of alkylmetals, preconcentration by cryogenic trapping on chromatographic packing material, speciation by mild thermal desorption, detection in a quartz heated furnace aligned in the beam of an atomic absorption spectrometer and electronic integration of the signal. This paper summarizes optimizing and limiting conditions from the different methods developed. Environmental application of these techniques on extractions of methyltin compounds from sediments are presented and discussed. (Author's abstract)
W88-09567

ANALYSIS AND FATE OF DIBENZOTHIOPHENE DERIVATIVES IN THE MARINE ENVIRONMENT,
Centre National de la Recherche Scientifique, Brest (France). Lab. de Chromatographie.
For primary bibliographic entry see Field 5B.
W88-09568

CONCENTRATIONS OF DIOXINS AND DIBENZOFURANS IN THE ATMOSPHERE,
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 5B.
W88-09570

RECENT METHODOLOGICAL PROGRESS IN CADMIUM ANALYSIS,
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Angewandte Physikalische Chemie.
M. Stoeppler.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 3, p 231-239, November 1986. 2 tab, 39 ref.

Descriptors: *Heavy metals, *Chemical analysis, *Tissue analysis, *Cadmium, Atomic absorption spectroscopy, X-ray fluorescence, Polarographic analysis, Neutron activation analysis.

The state-of-the-art of methodology for cadmium analysis in biological and environmental materials on the basis of recent progress reports is discussed. There is a remarkable gain in the sensitivity and reliability for atomic spectroscopy mainly for graphite furnace techniques but to some extent also for flame atomic absorption with Zeeman background correction. Further, the introduction of new commercial polarographic analyzers offering square wave voltammetry made this method less prone to sample pretreatment performance, particularly for the analysis of somewhat higher contents. Another promising new and sensitive method is Total Reflection X-ray Fluorescence (TXRF). Because of this technical progress and the existence of 'classical' methods (e.g., isotope dilution mass spectrometry) as well as the increased availability and use of biological and environmental reference materials, a broad selection of appropriate analytical approaches is at hand for numerous research and surveillance duties. (Author's abstract)
W88-09571

DETERMINATION OF 'HEAVY' ORGANOTIN POLLUTION OF WATER AND SHELLFISH BY A MODIFIED HYDRIDE ATOMIC ABSORPTION PROCEDURE,
Universite de Pau et des Pays de l'Adour (France). Lab. de Chimie Analytique.
R. Pinel, and H. Madiec.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 4, p 265-271, December 1986. 3 tab, 11 ref.

Descriptors: *Heavy metals, *Tissue analysis, *Water analysis, *Atomic absorption, *Path of pollutants, *Tin compounds, *Shellfish, Oysters, Water pollution, Spectroscopy, Toxicity, Organotin compounds, Speciation.

Tin speciation in the aquatic environment is very complex. To the natural SnIV and methylated compounds, human activities add mainly butylated, octylated, phenylated or even methylated derivatives. Several sophisticated speciation procedures have been proposed. A simple and fast procedure allowing routine global distinction of 'heavy' tin species is proposed here. This atomic absorption (AA) method uses the differences in

volatility of stannanes generated by reduction with NaBH4. SnIV and the methylated species have very close response coefficients whereas 'heavy' compounds respond very slightly at room temperature and are eliminated in a -40 C cold trap. 'Heavy' tin determination in water is thus obtained by the difference between two hydride AA experiments, one performed on the untreated sample ('light tin') and the other on a UV mineralized subsample (total tin). The analysis of shellfish (oyster) tissue relies also on two experiments. Total tin is measured on a mineralized sample and 'light tin' is obtained on a subsample solubilized with an Ultra Turrax homogenizer in a diluted HCl solution. (Author's abstract)
W88-09573

POLAROGRAPHIC DETERMINATION OF LEAD IN DRINKING WATER SAMPLES OF WESTERN U. P. DISTRICTS WITH 3-HYDROXYPYRIDINE-2-THIOL,
M.S. Coll., Saharanpur (India). Dept. of Chemistry.
R. S. Sindhu.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 1+2, p 87-91, January 1987. 2 tab, 13 ref.

Descriptors: *Lead, *Drinking water, *India, Polarographic analysis, Water pollution, Pollutant identification, Public health.

The polarographic determination of lead in the presence of 3-hydroxypyridine-2-thiol (HPT) has been investigated. The method was applied to the determination of the lead concentration in drinking water samples from western Uttar Pradesh, India. Lead concentrations found in different districts are below the permissible values for lead in drinking water (50 micrograms/L) recommended by the committee of Public Health Engineering Manual and Code of Practice by the Ministry of Health, Government of India. (Author's abstract)
W88-09574

PETROLEUM CONTAMINATION OF THE SURFACE MICROLAYER OF THE FOS-SUR-MER GULF (MEDITERRANEAN SEA) (CONTAMINATION PETROLIERE DE LA MICRO-COUCHE DE SURFACE DU GOLFE DE FOS-SUR-MER (MER MEDITERRANEE)),
Centre d'Oceanologie de Marseille (France).
For primary bibliographic entry see Field 5B.
W88-09575

ORIGIN OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH) IN RECENT SEDIMENTS FROM THE CONTINENTAL SHELF OF THE 'GOLFE DE GASCOGNE' (ATLANTIC OCEAN) AND IN THE GIRONDE ESTUARY,
Bordeaux-1 Univ., Talence (France). Groupe d'Oceanographie Physicochimique.
For primary bibliographic entry see Field 5B.
W88-09576

ANALYSIS OF POLYCYCLIC AROMATIC HYDROCARBONS IN LACUSTRAL SEDIMENTS BY HIGH RESOLUTION SHPOL'SKII SPECTROFLUORIMETRY AT 10 K,
Universite de Savoie, Chambery (France). Lab. de Spectroscopie Moleculaire.
A. Saber, J. Jarosz, M. Martin-Bouyer, L. Paturel, and M. Vial.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 3, p 171-184, February 1987. 6 fig, 2 tab, 45 ref.

Descriptors: *Sediments, *Pollutant identification, *Spectroflurometry, Hydrocarbons, Shpol'skii spectrofluometry, Pyrenes, Performance evaluation.

Among the numerous sensitive analytical methods developed, the high resolution Shpol'skii spectroflurometry at 10 K is particularly suitable for quantitative determination of traces of polycyclic aromatic hydrocarbons (PAH) in complex mixture, because of its high selectivity and high sensitivity. Indeed, PAH incorporated into n-alkane matrix at low temperature yield high resolution fluorescence spectra of quasi lines with multiplet structure related to several insertion sites. A method for qualitative and quantitative analysis has been developed from these Shpol'skii spectra. Quantitative results have been obtained from various samples of water and air. In this paper, this method is carried out for quantitative determination of PAHs in lacustrine sediments (benzo(a)pyrene, benzo(k)fluroanthene, indeno(1,2,3-cd)pyrene, benzo(ghi)perylene, benzo(b)fluroanthene, benzo(j)fluroanthene, benzo(b)chrysenes, benzo(e)pyrene, pyrene, and perylene). An extraction and purification procedure of samples must be adapted to Shpol'skii spectroflurometry analysis. The choice of this sample treatment, depending on total organic pollution levels of sediments, is discussed. (Author's abstract)
W88-09579

DETERMINATION OF TRIALKYLLEAD SPECIES IN WATER SAMPLES,
Dortmund Univ. (Germany, F.R.). Inst. of Occupational Health.
M. Blaskewicz, G. Baumhoer, and B. Neidhart.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 3, p 207-214, February 1986. 3 fig, 2 tab, 15 ref.

Descriptors: *Water analysis, *Pollutant identification, *Lead compounds, *Chromatography, *Precipitation, Lead, Surface water.

An analytical compound procedure is described for the determination of trimethyl- and triethyllead in water samples like rain, melted snow and surface waters. The method consists of an enrichment step (adsorption onto and elution from silica gel), a chromatographic separation with column switching (high performance liquid chromatography including pre-column enrichment), and a spectrophotometric detection (chemical reaction detector). The detection limits for the whole procedure, starting with 500 ml sample volume, are 15 picogram (pg)/ml and 20 pg/ml for trimethyl- and triethyllead, respectively. The standard deviation for repeated analysis of a sample containing 9 pg Et3Pb(+)/ml is calculated to + or - 4%. The method also covers the analysis of the chemically mixed trialkyllead species Me2EtPb(+) and MeEt2Pb(+). The investigation of several water samples taken from different locations shows the presence of trimethyl- and triethyllead in the concentration range of 20-100 pg/ml. (Author's abstract)
W88-09580

IMPROVEMENT OF THE KJELDAHL METHOD FOR TOTAL NITROGEN INCLUDING ACID-HYDROLYZABLE PHOSPHORUS DETERMINATIONS IN FRESHWATER ECOSYSTEMS,
Chile Univ., Santiago. Dept. de Ciencias Ecologicas.
For primary bibliographic entry see Field 7B.
W88-09581

GC/MS, HPLC AND FAB MASS SPECTROPHOTOMETRIC ANALYSIS OF ORGANIC MICROPOLLUTANTS IN BARCELONA'S WATER SUPPLY,
Instituto de Quimica Bio-Organica, Barcelona (Spain). Lab. d'Espectrometria de Masses.
J. Rivera, F. Ventura, J. Caixach, M. DeTorres, and A. Figueras.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 29, No. 1+2, p 15-35, March 1987. 7 fig, 2 tab, 25 ref.

Descriptors: *Water analysis, *Drinking water, *Organic compounds, *Gas chromatography, *Pollutant identification, Llobregat river, Barcelona, Mass spectrometry, Spain, Liquid chromatography, Surfactants, Plasticizers, Phosphates, Hydrocarbons, Water supply, Water pollution.

Water samples from Llobregat river entering two water works plants, Barcelona tap water, and samples of waste discharges taken along the river course were analyzed for trace organic contaminants by different procedures, including liquid-liquid extraction, adsorption on granular activated carbon followed by gas chromatography/mass spectrometry/data system analysis. Ether-insoluble organic fractions were analyzed and fractionated by high performance liquid chromatography with diode-array detection, followed by FAB and FAB-CID-MIKE characterization. Results, after two years of monitoring, proved that surfactants, plasticizers, ethylene glycol derivatives, phosphates, hydrocarbons and other miscellaneous compounds can be considered as chronic pollutants of Llobregat river. Some of the compounds identified by GC/MS and FAB spectrometry have not been previously reported to occur in water. (Author's abstract)
W88-09583

TEST SYSTEM FOR THE DETERMINING OF THE FATE OF PESTICIDES IN SURFACE WATER: PROTOCOL AND COMPARISON OF THE PERFORMANCE FOR PARATHION OF ECOCORES AND MICRO ECOSYSTEMS FROM TWO SOURCES,
Institute for Pesticide Research, Wageningen (Netherlands).
N. W. H. Houx, and A. Dekker.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 29, No. 1+2, p 37-59, March 1987. 6 fig, 5 tab, 13 ref.

Descriptors: *Chemical analysis, *Pesticides, *Surface water, *Fate of pollutants, Tracers, Isotope studies, Radioactive tracers, Temperature, Light, Eutrophication, Parathion, Microenvironment, Comparison studies, Ecosystems, Testing procedures, Microcosms, Trophic level.

Protocols are described for constructing laboratory micro-ecosystems (MES), incubating then with radiolabelled pesticides and then using a routine test procedure to ascertain the fate of these pesticides in surface water. The performance of fresh ecocores and acclimated MES from two sources was compared. The influence of the duration of the acclimation to room temperature and a light cycle on the fate of parathion was studied. The variation between replicates of MES performed similarly, the oligotrophic ecocores transformed parathion faster than in oligotrophic MES. The eutrophic systems, reduction to aminoparathion was much faster than in oligotrophic systems. The sandy oligotrophic MES needed a longer acclimation to laboratory conditions than the eutrophic MES to produce reproducible results. The results of year-to-year experiments were also more reproducible for the eutrophic MES. (Author's abstract)
W88-09584

PCB TRACE ENRICHMENT FROM CONTAMINATED NATURAL WATER AT THE SUB PPT LEVEL ON C18 MICROCARTRIDGES,
Liege Univ. (Belgium). Zoology Inst.
J. P. Thome, and Y. Vandaele.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 29, No. 1+2, p 95-103, March 1987. 5 fig, 1 tab, 13 ref. FNRS grant 1.5.203.86 F.

Descriptors: *Polychlorinated biphenyls, *Water analysis, *Pollutant identification, *Water analysis, *Natural waters, Contamination, Trace level, Performance evaluation, Sorption, Silica gel.

A novel micromethod of PCB trace enrichment from contaminated water at the sub parts per thousands (ppt) level is described. This procedure involves quantitative adsorption of PCB on C18 microcartridges. This sorbent is a covalently bonded silicagel with octadecyl groups. PCBs are retained on the modified surface and subsequently eluted by appropriate apolar solvent prior to high resolution capillary gas chromatography. PCB recovery efficiency has been investigated in the concentration range from 0.01 to 10 ppb. This extraction method appears to result in high performance and rapid purification of dissolved PCB in natural water. The mean recovery percentage reached 95.2% (SD = 6.1%) within an overall procedure ranging 10 minutes. As a consequence, the simplic-

ity of use of this PCB trace enrichment makes it useful for field sampling as well as for laboratory experiments. (Author's abstract)
W88-09585

EFFECT OF FILTRATION AND CENTRIFUGATION ON THE DETERMINATION OF ALUMINUM IN WATER,
Norsk Inst. for Skogforskning, Aas.
For primary bibliographic entry see Field 7B.
W88-09586

CHARACTERISTIC LEVELS OF CHLORINATED HYDROCARBONS AND TRACE METALS IN FISH FROM COASTAL WATERS OF NORTH AND BALTIC SEA,
Stadtisches Unterscuhingsamt Flensburg (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W88-09588

ANALYTICAL CHEMISTRY OF CHROMIUM SPECIES IN THE ENVIRONMENT, AND INTERPRETATION OF RESULTS,
Bayer A.G., Leverkusen (Germany, F.R.).
A. C. Harzdorf.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 29, No. 4, p 249-261, May 1987. 4 fig, 4 tab, 31 ref.

Descriptors: *Heavy metals, *Pollutant identification, *Chemical analysis, *Chromium, Organic matter, Polarographic analysis, Speciation, Spectrophotometry, Atomic absorption spectrometry, Oxidations state, Hydrogen ion concentration, Valence-specific selection, Tissue analysis, Soil, Sediments, Natural waters, Effluents.

Valence-selective species determination of chromium in environmental and biological material presents intricacies primarily due to complex nature of the samples and the instability of the oxidation state of chromium. In particular, organic matter ubiquitously present in environmental samples introduces the risk of chromium(VI) reduction during analysis which takes place preferably in acidic solution. Also chromium(III) oxidation may occur in alkaline medium. Hence, analytical methods should be adequately adapted to the reliable determination of chromium(VI) in blood, natural water, effluents, sediments, and soil. It can be shown that polarography is most suitable to the determination of chromium(VI) compounds. Chromium(VI) is electrochemically active over the entire pH range, so that medium pH can be selected for measuring, thus protecting samples most effectively from undergoing redox reactions during the analytical procedure. Other established methods such as spectrophotometry or valence-specific extraction are more crucial because these generally require acidic medium. In some cases, sample pre-treatment can be employed to eliminate reductants prior to final measurement. Very few methods are available to selectively measure chromium(III). Indirect determination is therefore preferred. (Author's abstract)
W88-09589

DETERMINATION OF METHYL- AND ETHYLMERCURY IN NATURAL WATERS AT SUB-NANOGRAM PER LITER USING SCF-ADSORBENT PRECONCENTRATION PROCEDURE,
Swedish Environmental Research Inst., Goeteborg.
Y. H. Lee.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 29, No. 4, p 263-276, May 1987. 3 fig, 5 tab, 10 ref.

Descriptors: *Pollutant identification, *Natural waters, *Mercury, *Adsorption, Path of pollutants, Fate of pollutants, Nethylmercury, Ethylmercury, Snow, Decomposing organic matter.

An analytical procedure for determining methyl- and ethylmercury (MeHg/EtHg) in natural waters is described. MeHG/EtHg was preconcentrated from water on a sulfhydryl cotton fiber (SCF) adsorbent and eluted with a small volume of a mixture of 1 M hydrochloric acid and 2 M sodium chloride. The eluate was extracted with benzene. The measurements of MeHg/EtHg in benzene extract were determined by gas chromatography with electron capture detector. The detection limit for MeHG/EtHg was about 0.04 ng/L using a 20 L water sample. The precision was about 20%. The application of the proposed method to one snow and four freshwater samples varying in humus content is described. The MeHg concentrations found in different freshwater samples were ranged from 0.09 to 0.22 ng/L and the recoveries of spiked MeHg were ranged from 42 to 68% (these were strongly correlated to the content of humic substances). The MeHg concentration found in snow was 0.28 ng/L and the recovery was 79%. The analytical results of MeHg concentration in freshwater samples are discussed in relation to the pH used in preconcentration, the humus content, the fraction of methylmercury in organic bound mercury and mercury in fish. (Author's abstract)
W88-09590

DETERMINATION OF ALKYLPHENOLS IN REFINERY EFFLUENTS BY LIQUID CHROMATOGRAPHY USING ELECTROCHEMICAL DETECTION,
Latrobe Univ., Bundoora (Australia).
T. J. Caedwell, I. C. Hamilton, M. J. McCormick, and R. Y. Symons.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 1, p 23-35, January 1986. 4 fig, 3 tab, 17 ref.

Descriptors: *Pollutant identification, *Effluents, *Electrochemistry, *Chromatography, *Industrial wastes, *Water pollution, *Phenols, *Alkylphenols, *Liquid chromatography, Electrochemical detection, Alkylphenols, Refinery effluents.

The technique of liquid chromatography with electrochemical detection has been applied to the determination of alkylphenols in refinery effluents. Specific problems addressed were the trace enrichment of low-level phenols and the simultaneous detection of meta- and para-cresols which are difficult to separate chromatographically. The former problem was solved using C18 Sep Pak(TM) cartridges followed by controlled evaporation of the eluant. Separate responses for the meta- and para-cresols were achieved by using two different potentials. The fully developed method is sensitive and selective in the determination of alkylphenols in environmental waters. (Author's abstract)
W88-09596

FATE OF ATRAZINE AND TRIFLURALIN FROM AN INDUSTRIAL WASTE DUMPING AT THE LLOBREGAT RIVER: PRESENCE IN FISH, RAW AND FINISHED WATER,
Instituto de Quimica Bio-Organica, Barcelona (Spain).
J. Rivera, J. Caixach, and M. DeTorres.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 3, p 183-191, March 1986. 5 fig, 1 tab, 11 ref.

Descriptors: *Path of pollutants, *Waste disposal, *Atrazine, *Trifluralin, Industrial wastewater, Fish, Raw water, Drinking water, Spain, Llobregat River, Fate of pollutants, Pesticides, Herbicides, Animal tissues, Pollutant identification.

Analysis carried out after fish mortality in an industrial area near the Llobregat River, which supplies water to Barcelona, led to the identification of two herbicides (Atrazine and trifluralin) in the wastewaters from an industrial sewer from pesticide factories. The path of these herbicides is followed in fish (dorsal muscle), raw water entering the water works plant and tap water. Analyses by GC, GC/MS and mass fragmentography were routinely employed. (Author's abstract)
W88-09600

DETERMINATION OF BORON BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROSCOPY: II. APPLICATIONS TO SOUTH AFRICAN ENVIRONMENTAL SAMPLES,
Cape Town Univ. (South Africa). Dept. of Analytical Science.
M. A. B. Pougnet, and M. J. Orren.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 4, p 267-282, April 1986. 6 fig, 4 tab, 20 ref.

Descriptors: *Pollutant identification, *Path of pollutants, *Boron, *Spectroscopy, *Emission spectroscopy, Leaching, Lakes, Sediments, Lake sediments, Seawater, Inductively coupled plasma atomic emission spectroscopy, South Africa, Fly ash, Coal, Sample preparation.

The use of inductively coupled plasma atomic emission spectroscopy (ICP-AES) for trace determination of boron in a variety of samples is illustrated. The sample preparation method for the analysis of coal and fly ash is described and data for boron levels in South African samples are presented. ICP-AES is also used to investigate the leaching of boron from fly ash by water and to analyze waters, including lake water, sea water and water samples collected at a coal burning plant. (Author's abstract)
W88-09602

DETERMINATION OF ULTRA TRACE AMOUNTS OF COBALT IN FISH BY GRAPHITE FURNACE ZEEMAN EFFECT ATOMIC ABSORPTION SPECTROMETRY,
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
J. W. McMahon, A. E. Docherty, J. M. A. Judd, and S. Genter.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 4, p 297-303, April 1986. 2 fig, 2 tab, 8 ref.

Descriptors: *Pollutant identification, *Cobalt, *Fish, *Path of pollutants, *Trace elements, *Spectrophotometry, *Atomic absorption spectrophotometry, Animal tissues, Tissue analysis.

A method is described for determining stable cobalt concentrations in fish flesh and bone using polarized Zeeman effect graphite furnace atomic absorption spectrometry (ZAAS). Cobalt analysis on freshwater fish flesh samples (10 g dry weight) required predigestion and wet-ashing at 70-80 degrees. Cobalt is chelated with ammonium pyrrolidine dithiocarbamate extracted with methyl isobutyl ketone and analyzed by ZAAS. The mean cobalt content calculated from the standard additions method using three replicate fish flesh samples was 4.23 + or - 1.0 micrograms Co/Kg (dry weight). Analyses were also carried out on flesh and bone samples from similar sized fish, of the same species, taken from three area lakes. (Author's abstract)
W88-09603

QUANTITATIVE DETERMINATION OF TRACE CONCENTRATION OF ORGANICS IN WATER BY SOLVENT EXTRACTION AND FUSED SILICA CAPILLARY GAS CHROMATOGRAPHY: ALIPHATIC AND POLYNUCLEAR HYDROCARBONS,
National Centre for Scientific Research, Havana (Cuba).
L. G. Bravo, and L. Rejthar.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 4, p 305-318, April 1986. 4 fig, 5 tab, 18 ref.

Descriptors: *Pollutant identification, *Organic compounds, *Trace levels, *Gas chromatography, Hydrocarbons, *Aliphatic hydrocarbons, Water pollution, Polynuclear aromatic hydrocarbons, Quantitative analysis.

Solvent procedures with six different solvents on aqueous model systems of aliphatic (C12-C22) and polynuclear aromatic hydrocarbons (PAHs: Naphthalene, acenaphtene, fluorene, phenanthrene, anthracene, fluoranthene and pyrene) were studied for the analysis in the trace concentration range (20-50 ng/ml) by fused silica capillary gas chromatography. Recovery efficiences, reproducibilities and detection limits for each analyte and proce-

dure are reported. The effect of PAHs on the extracting rate of the aliphatic hydrocarbons at the trace concentration range is discussed. (Author's abstract)
W88-09604

HANDLING OF ENVIRONMENTAL AND BIOLOGICAL SAMPLES VIA PRE-COLUMN TECHNOLOGIES,
Vrije Univ., Amsterdam (Netherlands). Dept. of Analytical Chemistry.
R. W. Frei, M. W. F. Nielen, and U. A. T. Brinkman.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 25, No. 1-3, p 3-35, June 1986. 18 fig, 3 tab, 20 ref.

Descriptors: *Pollutant identification, *Sample preservation, *Chromatography, *Biological samples, Automation, Trace enrichment, Water sampling, Water pollution.

Sample handling is still a weak point in chromatography and in analytical chemistry, in general. One consideration is the automation potential of new procedures. Solid-liquid extraction techniques in combination with pre-column technology are particularly promising. The construction and geometry of pre-columns, both for conventional and narrow-bore high-pressure liqud chromatography, are of major importance since band broadening should be kept at a minimum for an optimal functioning of the analytical system. The various operations that can be carried out with such a pre-column are trace-enrichment, clean-up of the sample (which depends on the type of adsorbents used in the precolumn), ion exchangers or metal covered surfaces, protection of the analytical column, field sampling and storage of samples and as a substrate for on-column chemical derivations. These various operations are demonstrated with practical examples from the fields of environmental and biological analysis. The selectivity can further be enhanced by coupling precolumn technology with selective detection modes such as diode array UV, electrochemical or fluorescence detection. This enables the construction of optimal and integrated analysis systems which are fully automated and microprocessor controlled. They can also be made compatible with miniaturized LC technology. (Author's abstract)
W88-09605

TRACE-LEVEL DETERMINATION OF PHENOL BY LIQUID CHROMATOGRAPHY WITH ON-LINE PRECOLUMN TECHNOLOGY AND FLUORESCENCE DETECTION,
Vrije Univ., Amsterdam (Netherlands). Dept. of Analytical Chemistry.
M. W. F. Nielen, J. DeJong, R. W. Frei, and U. A. T. Brinkman.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 25, No. 1-3, p 37-48, June 1986. 3 fig, 2 tab, 8 ref, append. Dutch Foundation for Technical Services Grant No. CH 44.0616.

Descriptors: *Pollutant identification, *Trace levels, *Phenols, *Chromatography, *Fluorescence, Water sampling, Drinking water, Water pollution, Anion exchange.

A strongly basic anion-exchange resin is used for the trace enrichment and automated sample handling of phenol with subsequent determination by reversed-phase liquid chromatography with fluorescence detection. Because of the presence of high concentrations if ionic compounds in the water samples tested, phenol is first trapped on a relatively long precolumn filled with highly hydrophobic packing material. During this step, organic anions which are not retained are flushed to waste. In the next step, phenol is desorbed from this column at high pH and sorbed in a small zone ('peak compression') on a short precolumn containing the anion exchanger. In the analysis of tap and river water samples, the detection limit was found to be 10 ppt. (Author's abstract)
W88-09606

FIELD TESTING OF A LARGE VOLUME LIQUID-LIQUID EXTRACTION DEVICE FOR HALOGENATED ORGANICS IN NATURAL WATERS,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
B. G. Oliver, and K. D. Nicol.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 4, p 275-285, June 1986. 1 fig, 5 tab, 12 ref.

Descriptors: *Pollutant identification, *Laboratory equipment, *Organic compounds, *Natural waters, Trace levels, Field tests, Testing procedures, Water pollution.

The testing of a large volume (200 litre) liquid-liquid extractor for trace organics in the laboratory and in the field is described. The recovery efficiency of the device, as measured by laboratory spiking experiments and field spiking of five surrogate chemicals was reasonably consistent and in the 40-70% range. Concentration and cleanup procedures for the extract are described in detail. The device reduces the detection limits of the organic chemicals by one or two orders of magnitude over those achieved with conventional small volume (1-10 l) samples. (Author's abstract)
W88-09610

COMPARISON OF FREQUENTLY USED METHODS FOR THE DETERMINATION OF AQUEOUS ALUMINUM,
Senter for Industriforskning, Oslo (Norway).
T. J. Sullivan, H. M. Seip, and I. P. Muniz.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 26, No. 1, p 61-75, July 1986. 4 fig, 3 tab, 32 ref.

Descriptors: *Pollutant identification, *Chemical analysis, *Aluminum, *Acid rain, Comparison studies, Soil, Surface waters, Toxicity, Chemical speciation.

In view of current international interest in the effects of acid deposition and consequent aluminum mobilization, a need has arisen to establish sound relationships between aluminum fractionation methodologies. The results of two principal fractionation methods, the Barnes/Driscoll MIBK extraction method and the pyrocatechol violet method, for surface water samples from southern Norway are compared. For samples analyzed immediately after collection with minimum pH and temperature changes, both methods are satisfactory. But, the Barnes/Driscoll method was found to be more convenient for field analytical research. There are systematic differences, particularly for the organic monomeric aluminum fraction. Results for inorganic monomeric aluminum, which is most important biologically, are in very good agreement. (Author's abstract)
W88-09614

SIMPLE DEVICE FOR ISOLATION OF ORGANIC COMPOUNDS FROM WATER,
Gdansk Technical Univ. (Poland). Inst. of Inorganic Chemistry and Technology.
M. Biziuk, and J. Namiesnik.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 26, No. 3+4, p 193-207, September 1986. 9 fig, 3 tab, 29 ref. Institute of Oceanology Grant MR.I-15.

Descriptors: *Pollutant identification, *Laboratory equipment, *Organic compounds, Water sampling, Chlorine, Isolation, Colorimetry, Organochlorine compounds.

A simple device for the isolation of organic compounds from aqueous samples has been designed and its operating parameters tested during both periodic and continuous operation using isolation of organochlorine compounds as an example. A stream of an aqueous sample is pumped at elevated temperature by a piston pump to a unit for expansion of the liquid phase surface, where the liquid is sprayed on the walls of the unit and flows down freely. Organochlorine compounds passing to the gaseous phase are purged with a stream of purified air and oxidized and the chlorides formed are determined coulometrically. The device, due to its simplicity, can be built and employed in an average laboratory. (Author's abstract)
W88-09617

LINEAR ALKYLBENZENE SULFONATES (LAS) IN SEWAGE SLUDGES, SOILS AND SEDIMENTS: ANALYTICAL DETERMINATION AND ENVIRONMENTAL SAFETY CONSIDERATIONS,
Procter and Gamble/ETC, Strombeek, Bever (Belgium).
H. DeHenau, E. Mathijs, and W. D. Hopping.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 26, No. 3+4, p 279-293, September 1986. 3 fig, 9 tab, 32 ref.

Descriptors: *Pollutant identification, *Chemical analysis, *Linear Alkyl Sulfonates, *Wastewater, *Sludge, Path of pollutants, Wastewater treatment, Benzenes, Surfactants, Sediments, Soils, Soil contamination, Safety, Chromatography.

Linear Alkylbenzenesulfonate (LAS), a major anionic surfactant used in laundry products, can be measured specifically in the environment by instrumental analysis. In addition to a desulfonation-gas chromatography approach, a method based on high performance liquid chromatography has been developed. the main features of the methods are outlined and LAS concentrations measured in sewage sludge, sediments and sludge amended soils are reported. Knowledge of usage volumes, sewage treatment practices and environmental transport and transformation mechanisms has been used to predict concentrations of LAS. These calculated concentrations were found to agree well with those actually measured in the environment. Both measured and calculated ambient concentrations of LAS are below those which could produce potentially adverse effects in representative surface water, benthic and terrestrial organisms. (Author's abstract)
W88-09618

WATER QUALITY STUDIES ON BUCKINGHAM CANAL (MADRAS, INDIA): A DISCRIMINANT ANALYSIS,
Presidency Coll., Madras (India). Dept. of Zoology.
S. Ravichandran.
Hydrobiologia HYDRB8, Vol. 154, p 121-126, November 16, 1987. 7 tab, 14 ref.

Descriptors: *Water quality, *Pollutant identification, *Biological properties, *Canals, *Mathematical analysis, Discriminant analysis, India, Madras, Physical properties, Chemical properties, Pollutants.

Stepwise multiple discriminant analysis was applied to a two-year water quality monitoring study of the Buckingham Canal. The variables were divided into (1) physical and chemical, (2) pollutants, and (3) biological, to test which group is efficient in discriminating stations which differ in water quality. Biological variables obtained higher loadings on the discriminant functions than the other two groups. The derived discriminant functions were tested for their discriminating power through the classification phase with the same raw data. The 'Hit and Misses' tables of classification indicate that 81.66% of the samples were correctly classified by the biological variables, against only 46.66% of the samples in the case of physical and chemical variables and 48.33% in the case of pollutants. (Author's abstract)
W88-09641

AROMATIC SURFACTANTS IN LAUNDRY DETERGENTS AND HARD-SURFACE CLEANERS: LINEAR ALKYLBENZENESULPHONATES AND ALKYLPHENOL POLYETHOXYLATES,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
A. Marcomini, F. Filipuzzi, and W. Giger.
Chemosphere CMSHAF, Vol. 17, No. 5, p 853-863, 1988. 2 fig, 4 tab, 29 ref.

Descriptors: *Organic compounds, *Surfactants, *Detergents, Chromatography, Isomers, Molecular structure, Water pollution sources, Chemical properties, Chemical analysis, Switzerland.

Linear alkylbenzenesulphonates (LAS) and alkylphenol polyethoxylates (APEO) were determined in granular laundry detergents and liquid hard-surface cleaners commercially available in Switzerland. Quantitative measurements were performed by reversed- and normal-phase high-performance liquid chromatography. The distribution of homologous LAS and of the phenyl positional isomers within each homologue are presented together with the distribution of oligomeric APEO. Levels of LAS and APEO were: 1.5 to 12% and 0.5 to 6%, respectively, in the laundry detergents, and 2.8 and 3.6% and 7.0 and 25.1% in the hard-surface cleaners. The most abundant components of LAS contained aliphatic chains with 11 and 12 carbon atoms. The distributions of APEO oligomers centered around compounds with eight or nine ethoxy units. (Author's abstract)
W88-09652

PRECONCENTRATION AND ANALYSIS OF TETRAPHENYLBORON AND DIPHENYLBORINIC ACID IN NATURAL WATERS USING C18 REVERSE-PHASE LIQUID CHROMATOGRAPHY,
Savannah River Ecology Lab., Aiken, SC.
G. L. Mills, D. Schwind, and D. C. Adriano.
Chemosphere CMSHAF, Vol. 17, No. 5, p 937-942, 1988. 1 fig, 3 tab, 19 ref. US DOE Contract DE-AC09-76ROO-819.

Descriptors: *Boron compounds, *Pollutant identification, *Chromatography, *Chemical analysis, Organic acids, Dissolved organic matter, Organic compounds, Path of pollutants, Chemical interference, Blackwater streams, Decomposing organic matter.

Tetraphenylboron (TPB) and diphenylborinic acid (DPBA) were concentrated from aqueous solutions using C18 reverse-phase liquid chromatography. Percent recoveries from solutions containing between 0.05 and 1.99 ug/ml were 94.6% and 82.8% for TPB and DPBA, respectively. The effect of solution volume was also investigated; the results indicated that up to 50 ml of sample can be processed through a column without significant loss in recovery efficiency. Naturally-occurring dissolved organic matter present in a black water coastal plain stream did not interfere in the retention or elution efficiencies for these organoborates. (Author's abstract)
W88-09654

TEMPORAL VARIATION OF METALS IN THE SEAGRASS POSIDONIA AUSTRALIS AND ITS POTENTIAL AS A SENTINEL ACCUMULATOR NEAR A LEAD SMELTER,
Commonwealth Scientific and Industrial Research Organization, Hobart (Australia). Marine Labs.
T. J. Ward.
Marine Biology MBIOAJ, Vol. 95, No. 2, p 315-321, July 1987. 1 fig, 4 tab, 35 ref.

Descriptors: *Pollutant identification, *Path of pollutants, *Temporal distribution, *Heavy metals, *Seagrass, *Posidonia australis, *Bioaccumulation, *Bioindicators, Biological magnification, Lead smelters, Mineral industry, Lead, Cadmium, Copper, Manganese, Nickel, Zinc, Leaves, Grasses, Marine plants, Metals, Australia, Industrial wastes, Seasonal variation, Plant growth.

Temporal variation in the concentrations of Cd, Cu, Mn, Ni, Pb and Zn in leaves of the seagrass Posidonia australis was studied at three sites near a lead smelter on the shore of Spencer Gulf, a large hypersaline marine embayment in South Australia, on four occasions from October 1980 to September 1981. Concentrations of Cd, Mn, Pb and Zn of up to 541, 537, 379, and 4,241 micrograms/g, respectively, were found in leaves collected from the site nearest to the smelter. A substantial temporal variation in the concentrations of these metals in samples from all sites resulted from the combined effect of leaf age and collection strategy. Concentrations of Cd, Cu and Zn in the leaf epibiota were lower than those in the leaves, but the reverse was true for Mn and Ni. The use of seagrass leaves as sentinel accumulators for Cu, Pb and Zn must be based on collections made at the same time of year, or otherwise account for the effect of leaf age on concentrations of the metal in the samples. (Author's abstract)
W88-09667

ELEMENTAL COMPOSITION OF THE SUBAQUATIC LIVERWORT PELLIA ENDIVIIFOLIA (DICKS.) DUM. IN RELATION TO HEAVY METAL CONTAMINATION,
National Inst. for Environmental Studies, Yatabe (Japan).
For primary bibliographic entry see Field 5B.
W88-09673

NOTE ON THE PROBLEM OF USING BIOLOGICAL SURVEYS TO ASSESS WATER QUALITY IN SMALL ALPINE TORRENTS,
Milan Univ. (Italy). Ist. di Biologia.
G. Crosa, and M. Cotta Ramusino.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 175-178, April-June 1988. 2 fig, 1 tab, 7 ref.

Descriptors: *Water quality assessment, *Pollutant identification, *Bioindicators, *Rivers, Water quality, Pollutants, Viola Torrent, Italy, Oligotrophy, Mapping, Surveys, Species diversity, Benthos, Dam effects, Water transfer.

Biological surveillance techniques have been widely used to assess river water quality. A biological survey using the E.B.I. method, which is based on the sensitivity of various taxa toward pollutants and on the variety of the macrobenthic communities, was carried out in the Viola Torrent, a mountain stream in Italy subject to water transfers from hydroelectric power plants and receiving the aqueous effluents from some villages. The investigation showed that the oligotrophy of the torrent brought about a simplification of the macrobenthic community and led to an inaccurate assessment of the quality of the water. A tendency to undervalue the complex interconnections in the biology of watercourses with sharp variations in fall and current velocity also led to inaccuracies. Therefore, a critical application of the mapping method was adopted in which the microtypologies present in the reaches under examination were mapped and the benthos in the microtypologies were sampled separately and compared to previously defined macrobenthic structures for similar microtypologies in natural conditions. (Wood-PTT)
W88-09727

HYDROCHEMICAL CHARACTERIZATION OF BRINES AND IDENTIFICATION OF BRINE CONTAMINATION IN AQUIFERS,
Kent State Univ., OH. Dept. of Geology.
S. A. Novak, and Y. Eckstein.
Ground Water GRWAAR, Vol. 26, No. 3, p 317-324, May-June 1988. 7 fig, 3 tab, 22 ref.

Descriptors: *Groundwater pollution, *Saline water intrusion, *Contamination, *Aquifer characteristics, *Brines, *Drilling, Calcium, Magnesium, Sodium, Chloride, Potassium, Water pollution sources, Stratigraphy, Graphical analysis, Ohio.

Hydrochemical investigations of aquifer contamination by brine are usually approached using conventional graphical methods (i.e. Stiff, Piper and Schoeller diagrams). While these methods may be used successfully to identify brine in distinction from other contaminants (e.g., road deicing agents) in ground water, they are unsuccessful in differentiating between brine contaminants from different stratigraphic origins. A methodology is described for hydrochemical investigations of suspected brine contamination, which incorporates the use of select ionic ratios (Ca:Mg, Na:Ca, Na:Mg, Na:Cl, K:Cl, K:Na, Mg:K, Ca:K, Cl:Mg, Cl:Ca, and (Ca + Mg):(Na + K)) in discriminant analysis and modified graphical methods. The method is tested by applying it to an area of known brine contamination in northeastern Ohio. The results of the test indicate that the method is successful in identifying brine as a contaminant in ground water and in identifying the stratigraphic origin of the brine. The method, when combined with information obtained from drilling reports, can be used to suggest a point source for the brine contamination. (Author's abstract)
W88-09785

BACTERIAL ASSIMILATION OF DISSOLVED AND PARTICULATE PHYTOSYNTHESIS PRODUCTS (BAKTERIELLE NUTZUNG VON GELOSTEN UND PARTIKULAREN PHOTOSYNTHESEPRODUKTEN),
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 2H.
W88-09813

ECOLOGICAL INVESTIGATIONS ON CILIATES IN THE PERIPHYTON OF TWO MOUNTAIN BROOKS POLLUTED BY ORGANIC WASTE WATER (METTMA AND GUTACH/WUTACH, SOUTHERN BLACK FOREST) (OKOLOGISCHE UNTERSUCHUNGEN AN AUFWUCHSCILIATEN ZWEIER ABWASSERBELASTETER GEBIRGSBACHE (METTMA UND GUTACH/WUTACH, SUDSCHWARZWALD)),
Bayerische Landesanstalt fuer Wasserforschung, Wielenbach (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W88-09893

DETERMINATION OF DISSOLVED CO2 IN UPLAND STREAMWATER,
Institute of Hydrology, Wallingford (England).
C. Neal.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 127-142, May 1988. 9 fig, 1 tab, 12 ref.

Descriptors: *Acid rain effects, *Path of pollutants, *Water analysis, *Chemical analysis, *Carbon dioxide, Titrations, Analytical methods, Alkaline water, Solute transport, Mathematical studies, Streams, Wales.

Data are presented for acidimetric titrations of two stream waters that could be affected by atmosphere acid deposition, the Afon Hafren and the Afon Hore, draining the Hafren spruce and pine forest at Plynlimon, mid-Wales. Results show variations of alkalinity of -30 to + 50 micro-equiv/L for the Afon Hafren and the -30 to + 250 micro-equiv/L for the Afon Hore. The large range of alkalinities reflects hydrological changes; storm-flow waters are derived from the upper organic soils where H(+) is generated and acidic conditions predominate, while low-flow waters are derived from the lower inorganic soils where weathering results in H(+) assimilation from solutions draining the upper soil horizons. The larger range in alkalinity values for the Afon Hore compared with the Afon Hafren reflects the higher degree of calcium carbonate mineral veining within the bedrock of the Afon Hore catchment. Preliminary estimates of the pCO2 contents of the two stream waters are 1 to 5 times atmospheric values particularly at low flows (high pH) but values of up to 30 times atmospheric values are occasionally found at high flows (low pH). However, such high values at high flows are in part questionable owing to the potential importance of buffering components other than HCO3(-) in the water, although excess pCO2 is partially correlated with flow. To allow HCO3(-) determinations from pH 4.5 alkalinity measurements, a new equation is presented. (Author's abstract)
W88-09920

SELENIUM AND HUMAN HEALTH IMPLICATIONS IN CALIFORNIA'S SAN JOAQUIN VALLEY,
California Dept. of Health Services, Berkeley. Office of Environmental Health Assessment.
For primary bibliographic entry see Field 5B.
W88-09960

PHENOTYPIC AND GENOTYPIC COMPARISON OF ESCHERICHIA COLI FROM PRISTINE TROPICAL WATERS,
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
M. Bermudez, and T. C. Hazen.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 4, p 979-983, April 1988. 1 fig, 2 tab, 32 ref.

Descriptors: *Escherichia coli, *Bacteria, *Fecal contamination, *Bioindicators, *Human wastes, *Water quality, *Puerto Rico, *Tropical regions, Biological properties, Radioactive tracers, Genetic analysis, Deoxyribonucleic homology, Genetics.

Nine fecal-coliform-positive strains were isolated from pristine sites in a tropical rain forest. These sites included nonpolluted rivers and water from bromeliads (epiphytes) which were 30 ft (ca. 910 cm) above the ground. Phenotypically, all of these isolates were as Escherichia coli. Their DNA was isolated and purified, and the base content (G plus C content) was determined and compared with that of E. Coli B (ATCC 11303). The DNA from the environmental isolates was also hybridized to radiolabeled DNA from E. coli B. Eight strains had a similar DNA base composition to that of E. Coli B and gave more than 75% homology with the reference strain. The finding of E. coli in pristine tropical waters suggests that this bacterium could be a natural inhabitant in these environments and is not a reliable indicator of recent human fecal contamination in tropical waters. The indicators that are currently used in the tropics to test the biological quality of water should be reevaluated. (Author's abstract)
W88-09966

NORMALLY DISTRIBUTED SAPROBIC INDEX DATA FROM THE BLAGOEVGRADSKA BISTRITZA RIVER,
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
N. D. Natchev.
Hydrobiology, Vol. 30, p 81-93, 1987. 2 fig, 4 tab, 15 ref.

Descriptors: *Frequency distribution, *Rivers, *Saprobic index, *Statistical method, *Water quality, Mathematical models, Ecology, Aquatic environments, Blagoevgradska Bistritza River, Bulgaria, Pollution index, Benthic Fauna.

The frequency distribution of Rothschein's saprobic index (Sr) data obtained during the period 1970-1981 was examined for its agreement with the normal distribution. Graphic, parametric, and nonparametric tests were employed with a total of 131 Sr values from the Blagoevgradska Bistritza River (Bulgaria). The data distribution is in best agreement with normality when the sample is from stations with improved oligosaprobity. The agreement is very good when the number of polluted stations for the sample of data is the same as or very close to the number of unpolluted stations. The statistics of the tests chi-square and d (Geary's kurtosis) have extended values when the data are from polluted stations only. The calculated values of the test Chi-square and d are close to the tabulated critical values when the parity of polluted and unpolluted stations for the sampling of data is considerably upset. One can mark four parts from the length of the river in which the Sg data are normal distributed according to the Chi-square test. One can mark also four other parts from the river with normally distributed Sr data according to the test d. According to the Kolmogorov (K) test the data in samples from all the stations are normally distributed. (Roseman-PTT)
W88-09972

ASSESSMENT AND COMPILATION OF GROUNDWATER QUALITY DATA FOR MISSISSIPPI,
Mississippi State Univ., State College. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W88-10027

DETERMINATION OF BENTHIC-INVERTEBRATE INDICES AND WATER-QUALITY TRENDS OF SELECTED STREAMS IN CHESTER COUNTY, PENNSYLVANIA, 1969-80,
Geological Survey, Harrisburg, PA. Water Resources Div.
C. R. Moore.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources Investigations Report 85-4177, 1987. 62 p, 48 fig, 6 tab, 43 ref.

Descriptors: *Bioindicators, *Water pollution, *Benthic invertebrates, *Species diversity, *Trend analysis, *Water quality, *Limnology, *Pennsylvania, Urbanization, Biology, Chester County.

The trends of biological and chemical data collected for 12 years (1969-80) from 46 sites in Chester County were evaluated by using the seasonal Kendall test. Calculated Brillouin's diversity indices were plotted against time for each site. Seven sites had upward trends significant at the 99% confidence level, 9 sites had upward trends significant at the 95 to 98% confidence level, 11 sites had upward trends significant at the 90 to 94% confidence level. Of the remaining 19 sites, 17 had upward and 2 had downward trends, but these trends were not statistically significant. The seasonal Kendall test was used to test the chemical data for temporal trends at eight sites having stream discharge data. Significant trends were found at one or more sites for specific conductance, pH, total nitrate, total phosphorus, dissolved chloride, and dissolved sulfate. The chemical data for 11 sites, which were not flow adjusted were tested for trends by plotting against time and determining a correlation coefficient. Significant trends were found in nitrate and chloride. Selected chemical constituents were tested by regression analysis for correlation with diversity index. Only total dissolved solids correlated significantly with diversity index. Several suggestions are made to improve the monitoring program. (USGS)
W88-10063

TRACE ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN WATER BY GC AND HPLC,
Iowa State Univ., Ames. Dept. of Chemistry.
I. A. Ogawa.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8627141. Ph.D Dissertation, 1986. 190 p, 25 fig, 21 tab, 205 ref.

Descriptors: *Water analysis, *Pollutant identification, *Volatility, *Organic compounds, *Gas chromatography, *Gas liquid chromatography, *Trace levels, Aldehydes, Ketones, Distillation, Acids, Chemical analysis.

Low molecular weight aldehydes and ketones were determined in water by high performance liquid chromatography and low molecular weight polar compounds were determined in water by gas chromatography. The analysis of aldehydes and ketones was based on the formation of the 2,4-dinitrophenylhydrazine derivative. Changes that can be made in the purge and trap methods so that a greater variety of organic compounds can be analyzed by a single experiment are described. A single experiment using both gas purging followed by distillation with continued gas purging was used to concentration organic compounds. Shape selective zeolites, ZSM-5 and ELZ-115, were demonstrated to be capable of extracting polar low molecular weight compounds from water at the parts per billion level. Quantiation was best carried out using gas chromatography with large-bore columns. This method can be extended to low molecular weight compounds that are heat sensitive and cannot be distilled or thermally desorbed. The method is convenient for field sampling because only the mini-column needs to be transported to the laboratory for later analysis. (Cremmins-AEPCO)
W88-10077

5B. Sources Of Pollution

GROUND-WATER TRACERS,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W88-08971

SOIL GAS SENSING FOR DETECTION AND MAPPING OF VOLATILE ORGANICS,
Nevada Univ., Las Vegas. Environmental Research Center.
For primary bibliographic entry see Field 5A.
W88-08978

AGRICULTURE AND GROUNDWATER QUALITY.
Council for Agricultural Science and Technology, Ames, IA.
Council for Agricultural Science and Technology, Ames, Iowa. Report No. 103, May 1985. 62 p, 3 tab, 96 ref, append.

Descriptors: *Path of pollutants, *Irrigation, *Agriculture, *Groundwater quality, Water pollution sources, Pesticides, Soil amendments, Organic compounds, Fertilizers, Inorganic compounds, Gypsum, Nitrates, Bacteria, Salinity, Saline soils, Groundwater pollution, Feedlot runoff.

Agricultural production systems in the United States involve the use of fertilizers to supply plant nutrients; inorganic and organic amendments to improve soil quality; and pesticides to control weeds, insects, and other pests. Irrigation water is used in many areas where water is deficient. These practices are very important in agricultural production. One of their possible side effects, however, is the transport of chemicals to groundwater. Most of the chemicals used in agriculture do not accumulate in groundwater in important quantities except in unusual situations, but a few are of legitimate concern. In humid regions, the precipitation flushes dissolved salts from soils at intervals, and the salinity of the groundwater remains low because the precipitation is almost pure water, and there is a great deal of it relative to the amounts of salts present. In dry regions, the precipitation is supplemented by irrigation water, which always contains dissolved salts. When the water evaporates, the salts remain behind, and they increase the salt content of the soils. Excessive salinity in groundwater used for drinking is undesirable because of objectionable tastes and the laxative effect of the sulfate. Fertilizers add small amounts of salts to groundwater, but the principal concern is for the possible health implications of ingesting nitrate. Inorganic soil amendments (liming materials, acidifying materials, gypsum), organic residues, and pesticides are the other major sources of groundwater pollution. The principal concern about the possible effects of these residues on groundwater quality is for nitrate associated with feeding operations in out-of-door feedlots. Bacterial contamination also is of some concern. Both excess nitrate and bacterial contamination generally can be avoided by drilling farm wells deeper and properly casing them at upper levels to avoid entry of the contaminated water. As a result of loss from the soil by volatilization and decomposition, or retention by the soil, relatively few pesticides have been found in groundwater. To date, no verified adverse health effects appear to be on record as a result of pesticide residues in groundwater used for drinking. (Lantz-PTT)
W88-08979

GROUND WATER MONITORING AND MITIGATION EFFORTS AT AN INACTIVE TAILINGS POND IN NORTHWEST MONTANA,
K. R. Jones.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 69-93. 8 fig, 20 ref.

Descriptors: *Water pollution control, *Chemical treatment, *Industrial wastes, *In situ treatment, *Heavy metals, *Chemical precipitation, *Groundwater monitoring, *Groundwater pollution, *Leachates, Performance evaluation, Case studies, Groundwater, Montana, Monitoring wells,

Groundwater management, Aquifers, Wastewater treatment, Mineral industry, Antimony, Arsenic, Sulfides, Lysimeters.

The disposal of process fluids from an antimony refinery into an inactive fifteen acre tailings impoundment was investigated to determine the effect on local ground and surface water. Batch leach testing indicated a leachate containing 347 mg/L antimony and 11 mg/L arsenic would be produced by the tailings. Although high amounts of dissolved antimony and arsenic are currently available in the pond fluids through groundwater intrusion and precipitation, the foundation of the impoundment and the unsaturated zone provide major attenuation for the contaminants of concern. Due to concerns relative to the finite capabilities of the attenuation zone, several remedial measures were investigated. These measures included the removal of the tailings from the alluvial valley floor, capping the material in place, groundwater control, and in-situ treatment. Based upon review of the alternatives an in-situ treatment pilot program is being initiated. The treatment consists of using sulfide solutions to cause the antimony and arsenic found in solution to precipitate to less soluble forms. Monitoring wells, suction lysimeters located in the tailings, and batch leach tests on the treated tailings are being used to determine the effectiveness of the treatment. (See also W88-08991) (Author's abstract)
W88-08996

AMMONIA AND NITRATE MIGRATION FROM THE VADOSE ZONE TO THE GROUND WATER SYSTEM: CONTAINMENT, RECOVERY, AND NATURAL RESTORATION,
In-Situ, Inc., Laramie, WY.
For primary bibliographic entry see Field 5G.
W88-08997

MEASUREMENT OF HYDROLYSIS RATE CONSTANTS FOR EVALUATION OF HAZARDOUS WASTE LAND DISPOSAL: VOLUME 2. DATA ON 54 CHEMICALS,
Environmental Research Lab., Athens, GA.
J. J. Ellington, F. E. Stancil, W. D. Payne, and C. Trusty.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-227344. Price codes: A06 in paper copy, A01 in microfiche. August 1987. 152 p, 54 fig, 6 tab, 2 append. Report No. EPA/600/3-87/019.

Descriptors: *Hydrolysis, *Kinetics, *Path of pollutants, *Groundwater pollution, *Land disposal, *Hazardous wastes, Hazardous materials, Mathematical studies, Waste disposal, Chromatography, Regulations, Hydrogen ion concentration, Temperature, Mathematical models, Organic compounds.

To provide input data for a mathematical model to estimate potential groundwater contamination from chemicals in land disposal sites, hydrolysis rate constants were determined for 31 regulated chemicals under carefully controlled conditions. Hydrolysis rates were measured under sterile conditions at precisely controlled temperatures and at three pH levels (3, 7, and 11). Conditions were adjusted to provide sufficiently precise rate constants to meet modeling requirements determined through model sensitivity tests. In addition to close monitoring of temperature and pH, precautions were taken to minimize impact of adventitious processes. Chemical concentrations as a function of incubation time were measured by gas chromatography, liquid chromatography, or ion exchange chromatography. Identities and purities of the chemicals were determined by mass spectrometry supplemented, in some cases, by infrared spectrometry. Hydrolysis rate constants are reported for 54 compounds. (Author's abstract)
W88-09031

DENSE CHLORINATED SOLVENTS IN POROUS AND FRACTURED MEDIA: MODEL EXPERIMENTS,
F. Schwille.
Lewis Publishers, Chelsea, Michigan. 1988. 146 p.

Descriptors: *Hydrologic models, *Groundwater pollution, *Spills, *Fate of pollutants, *Path of pollutants, *Chlorinated hydrocarbons, *Model studies, Pore size, Infiltration, Porous media, Soil water, Saturated soils, Solute transport, Organic compounds, Soil properties.

Dense halogenated solvents are recognized as the cause of a large portion of the contemporary groundwater problem. Hundreds of Superfund sites in the United States are characterized by groundwater that is contaminated with these chemicals. While facilities that have handled large amounts of solvents have certainly been responsible for some of the current large-scale contamination problems, even a comparatively small leak of liquid solvent can cause very extensive contamination. It has been known for many years that these compounds are in general: (1) more dense and less viscous than water; (2) not nearly as biodegradable as other organic compounds; (3) quite soluble relative to the low levels which require regulatory action; (4) largely nonsorbing and therefore quite mobile in groundwater systems; and (5) rather volatile. In using experiments with physical models to lay out the principles governing the spreading of chlorinated hydrocarbons (CHCs) in the subsurface environment in a plausible manner, the general scenarios for the spreading of CHCs have been worked out. It is absolutely necessary that extended series of experiments be carried out to determine the individual parameters that control spreading. This should at least be done for the most important soil types and for several pertinent soil water contents. Conclusions from the study indicate that the sinking of CHCs in a water-saturated medium requires a certain CHC pressure in addition to excess CHC. That required pressure increases as the pore size of the medium decreases; in the smaller pore size media, the downward movement of a CHC usually comes to a halt quickly. It also confirms the fact that CHC compounds should generally be classified as very volatile. Few spill studies determine the water content of the porous medium. There is a big difference in behavior, however, when a solvent is spilled under a building where the soil is dry vs in the open where the soil is moist. In a dry medium, a given CHC can occupy the corners of the pores. It can also be held in substantial quantities in a medium with small pores. In a wet medium, however, these spaces are occupied by water. Under certain conditions a spilled CHC may infiltrate more rapidly in a moist medium than in a dry medium since all of the porosity is not available in the former to retain the CHC in residual saturation. (Lantz-PTT)
W88-09034

ORGANIC COMPOUNDS AT THE SRP OLD BURIAL GROUND FOR LOW-LEVEL RADIOACTIVE WASTE,
Savannah River Lab., Aiken, SC.
S. B. Oblath.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-011219. Price codes: A02 in paper copy, A01 in microfiche. 1987. 5 p, 3 fig, 1 tab, 6 ref. Contract No. DE-AC09-76SR00001. Report No. DP-MS-86-138.

Descriptors: *Radioactive wastes, *Solid waste disposal, *Path of pollutants, *Waste dumps, *Organic compounds, *Groundwater monitoring, *Monitoring wells, Organic matter, Soil water, Organic carbon, Test wells, Land disposal, Industrial wastes, Leaching, Monitoring, Groundwater pollution, Savannah River Plant, South Carolina, Humic acids, Mass spectrometry, Monitoring, Gas chromatography.

Between 1953 and 1972, the Savannah River Plant (SRP) disposed of its solid, low-level radioactive waste in a 31 hectare shallow land burial site. A grid of 63 monitoring wells covering the site were used to sample for organic species in the groundwater which might enhance the mobility of radionuclides in the soil/water system. Total organic carbon (TOC) measurements were used as a screening method to select which wells should be used for oxalates, tri-n-butyl phosphate, and EDTA. More thorough analyses were performed using gas chromatography and mass spectrometry for a number of the wells. Using this procedure over 60 compounds were identified. Spent solvents, scintillation wastes, and decomposing cellulosic wastes are believed to be the primary sources. None of the compounds were identified as strong complexing agents which would enhance migration. Preliminary experiments indicated that as much as 40% of the organic carbon may be humic material. These substances were not further characterized. However, humic materials have been implicated in increasing mobility of radionuclides in soil/water systems. (Author's abstract)
W88-09035

HUMIC SUBSTANCES REDUCE BIOAVAILABILITY AND TOXICITY OF CONTAMINANTS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
J. F. McCarthy.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009816. Price codes: A02 in paper copy, A01 in microfiche. No. CONF-870410-24. 1987. 20p, 3 fig, 57 ref.

Descriptors: *Organic matter, *Humic acids, *Bioaccumulation, *Toxicity, *Binding, *Aquatic life, Biological magnification, Daphnia, Amphipods, Adsorption, Fish, Heavy metals, Path of pollutants, Organic compounds, Fate of pollutants, Water pollution effects, Inorganic compounds.

The role of humic substances in the aquatic environment on the availability and toxicity of organic and inorganic contaminants is reviewed. Organic contaminants associated with humic substances appear to be essentially unavailable for uptake by amphipods, daphnids, and fish. Acute toxicity of these compounds is also diminished proportionally. Since the affinity of organic solutes for binding to humics is related to their hydrophobicity, the effect of humic substances is significant only for compounds with octanol-water partition coefficients $>$ 100,000. In most cases, association of toxic metals with humic substances reduces the uptake and toxic effects of the contaminants. However, complex interactions among the toxicants, humic ligands, other transition metals and major cations in solution, and the carrier proteins on biological membranes make it difficult to generalize and predict any reduction in accumulation and toxicity of metals. Humic substances may have secondary effects on uptake and accumulation of toxicants by biota through their role in altering the transport and fate of pollutants. (Author's abstract)
W88-09036

APPROACHES TO THE ASSESSMENT OF INJURIES TO SOIL ARISING FROM DISCHARGES OF HAZARDOUS SUBSTANCES AND OIL,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5C.
W88-09046

SOURCES OF PHOSPHATE WHICH GIVE RISE TO EUTROPHICATION IN SOUTH AFRICAN WATERS,
National Inst. for Water Research, Pretoria (South Africa).
H. N. S. Wiechers.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-225033. Price codes: E04 in paper copy, A01 in microfiche. 1985. 11 p, 3 tab, 24 ref.

Descriptors: *Phosphates, *Water pollution sources, *Eutrophication, *South Africa, *Detergents, Path of pollutants, Domestic wastes, Water pollution prevention, Water pollution control, Phosphorus removal, Industrial wastes, Nonpoint pollution sources, Fertilizers, Wastewater treatment.

Current knowledge on sources of phosphate which give rise to eutrophication in South African waters is reviewed, as well as the factors controlling the relative contributions from the different sources. Sewage and industrial effluents have been identified as the major point source contributors to the phosphate load on the water environment in South

Africa. The major sources of phosphate in domestic wastewater are human excreta and synthetic laundry detergents. Industry can either add or, in the case of a few phosphate-deficient discharges, dilute the phosphate content of municipal wastewaters. Industrial wastewaters typically high in phosphates include those generated from fertilizer production, feedlots, meat processing and packing, milk processing and commercial laundries. A detergent phosphate ban will significantly reduce the phosphate load on sewage works, but not to the level required by the effluent standards in South Africa. The legal infrastructure exists to force detergent manufacturers to specify the phosphate content of their products and, if desirable, to reduce or completely remove the phosphate. Diffuse sources of phosphates include: effluents from non-sewered populated areas, urban runoff, runoff from both cultivated and uncultivated land, spring and natural waters and both wet and dry atmospheric precipitation. Accurate and reliable information on phosphate loads and their sources is a prerequisite for the planning and management of a eutrophication control program. Another major information need is to establish the relative merits, based on costs and benefits, of removing phosphate from synthetic detergents as an alternative to removing it at sewage works. Basic knowledge is also needed on mechanisms of phosphate removal and transformation in river systems, as well as phosphate availability through sediment resuspension in impoundments. (Geiger-PTT)
W88-09047

ORGANOHALOGEN FORMATION TREATMENT AND CONTROL,
National Inst. for Water Research, Pretoria (South Africa).
D. I. Welch, and B. M. van Vliet.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-232617. Price codes: E05 in paper copy, A01 in microfiche. 1985. 24 p, 2 fig, 5 tab, 92 ref.

Descriptors: *Chlorination, *Organic compounds, *Water treatment, *Trihalomethanes, *Disinfection, *Organohalogens, Path of pollutants, Ozone, Coagulation, Algae, Activated carbon, Aeration, Ozonation, Population exposure, Public health, Biomass, Adsorption, Drinking water, Public health, Chlorine.

The discovery of the formation of trihalomethanes in potable waters as a direct effect of chlorine disinfection and the possible deleterious health effects of the long term ingestion of small quantities of haloforms is discussed. The classical haloform reaction and the factors which affect the rate of reaction are used to explain the formation of organohalogens in practice. Organohalogen precursors are classified into four categories, namely, humic substances, algal biomass and extracellular products, non-humic compounds, and pollutants. Control of organohalogen formation can be achieved by three strategies: removal of products; removal of precursors; and the use of alternative disinfectants. Each strategy is discussed in turn, with mention of aeration, coagulation, activated carbon adsorption, preoxidized adsorption, and the use of ozone, chlorine dioxide and chloramine oxidation. (Author's abstract)
W88-09049

PHOSPHATE DYNAMICS IN AQUATIC ECOSYSTEMS,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5C.
W88-09050

SOURCES AND FATES OF AQUATIC POLLUTANTS.
American Chemical Society, Washington, DC. Advances in Chemistry Series 216. Developed from a symposium sponsored by the Division of Environmental Chemistry at the 190th Meeting of the American Chemical Society, Chicago, IL, September 8-13, 1985. 1987. Edited by Ronald A. Hites and S. J. Eisenreich. 537 p.

Descriptors: *Fate of pollutants, *Water pollution sources, *Path of pollutants, *Chemical reactions, *Air-water interfaces, Marine sediments, Land sediments, Models, Air pollution, Trace elements, Metals, Organic compounds, Suspended solids, Ecosystems, Polychlorinated biphenyls, Mass transfer.

This book presents a holistic approach to aquatic pollutant chemistry and describes the relationship between physical mixing rates and chemical reaction rates. Four sections are covered in this volume: air-water processes, water column processes, water-sediment processes, and case studies. The first three sections emphasize the chemical and physical processes controlling solute behavior and fate in air and water. The case studies integrate information on these processes into a systemwide picture of the cycling of inorganic and organic chemicals. Specific topics include environmental modeling of hydrophobic organic compounds, air-sea transfer of trace elements, vapor-particle partitioning of semi-volatile organic compounds, and metal speciation in natural waters. This volume will be useful for atmospheric scientists, industrial chemists, marine scientists, environmental chemists, and students involved in the study of aquatic pollutants. (See W88-09066 thru W88-09081) (Geiger-PTT)
W88-09065

METHODS FOR ESTIMATING SOLUBILITIES OF HYDROPHILIC ORGANIC COMPOUNDS: ENVIRONMENTAL MODELING EFFORTS,
Wisconsin Univ.-Madison. Water Chemistry Program.
A. W. Andren, W. J. Doucette, and R. M. Dickhut.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 3-26, 4 fig, 2 tab, 71 ref.

Descriptors: *Mathematical models, *Fate of pollutants, *Organic compounds, *Thermodynamics, *Solubility, *Path of pollutants, Solute transport, Model studies, Physicochemical properties, Advection, Diffusion, UNIFAC method, Diffusion coefficient.

A variety of environmental fate models that integrate physicochemical properties of pollutants with advective and diffusive transport equations are now available. To satisfy the demand for missing input data, scientists have begun to incorporate property estimation techniques as part of their computational procedures. The recent appearance of high quality solubility data for polyhalogenated organic compounds makes it possible to evaluate several predictive schemes for these compounds. In this work, a brief review of the thermodynamics of hydrophobic compound solubility relationships is presented. This review is followed by an examination of the UNIFAC activity coefficient prediction technique. The use of octanol-water partition coefficients, total molecular surface areas, and molecular connectivity indexes to predict aqueous solubilities is then examined, and the resulting correlations are presented. (See also W88-09065) (Author's abstract)
W88-09066

VAPOR-PARTICLE PARTITIONING OF SEMI-VOLATILE ORGANIC COMPOUNDS,
South Carolina Univ., Columbia. Dept. of Chemistry.
T. F. Bidleman, and W. T. Foreman.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 27-56, 9 fig, 5 tab, 140 ref.

Descriptors: *Fate of pollutants, *Organic compounds, *Precipitation, *Water pollution sources, *Pesticides, *Polychlorinated biphenyls, *Air pollution, *Path of pollutants, Particulate matter, Chlorinated hydrocarbons, Vaporization, Aerosols, Urban areas.

Pesticides, polychlorinated biphenyls (PCBs), and other semivolatile organic compounds (SOCs) exist in air as vapors and are adsorbed to particulate matter. Estimates of the vapor-particle distribution and factors influencing it were obtained from high-volume sampling experiments using a glass fiber filter to collect particles and an adsorbent trap to collect vapors. Measurements of airborne organochlorine pesticides and PCBs in four cities over a wide temperature range were used to determine the partition coefficient A(TSP)/F, where A and F are the adsorbent- and filter-retained SOC concentrations (ng/cu m), respectively, and TSP is the total suspended particle concentration (micrograms/cu m). Laboratory determinations of A(TSP)/F were carried out by equilibrating particle-loaded filters at 20 degrees in an airstream containing controlled SOC vapor concentrations. Field and laboratory A(TSP)/F values agreed well for most organochlorines, with the exception of hexachlorobenzene (HCB). The A(TSP)/F value was closely correlated with the subcooled liquid vapor pressure of the SOCs, but not with the solid-phase vapor pressure. Implications of vapor-particle partitioning to the atmospheric deposition of SOCs are discussed. (See also W88-09065) (Author's abstract)
W88-09067

LAKE SEDIMENTS AS HISTORIC RECORDS OF ATMOSPHERIC CONTAMINATION BY ORGANIC CHEMICALS,
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
J. W. Astle, F. A. P. C. Gobas, W. Y. Shiu, and D. Mackay.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 57-77, 2 fig, 6 tab, 22 ref.

Descriptors: *Lake sediments, *Air pollution, *Organic compounds, *Dioxin, *Paleolimnology, *Mathematical models, Path of pollutants, Air-water interfaces, Air pollution effects, Model studies, Lake Superior, Siskiwit Lake, Particulate matter, Absorption, Degradation, Sediment-water interfaces.

A mathematical model is presented that describes the variation in lake sediment concentration of a persistent organic chemical with time and depth as a function of atmospheric concentrations. This model may be used to estimate historic atmospheric concentrations from analyses of sectioned sediments. The model includes wet and dry air particulate deposition;, rain dissolution, volatilization and absorption, water column particulate deposition and resuspension, sediment-water diffusion, degradation reactions in water and sediment, and sediment burial. If a chemical's properties are known, the dominant transfer processes can be identified, and it can be determined if the sediment can provide a reasonable record of atmospheric concentration. Defining surface sediment-air and water-air concentration ratios for organic chemicals may be feasible. The model is applied to dioxin concentration data from Siskiwit Lake on Isle Royale in Lake Superior. (See also W88-09065) (Author's abstract)
W88-09068

DEPOSITIONAL ASPECTS OF POLLUTANT BEHAVIOR IN FOG AND INTERCEPTED CLOUDS,
California Inst. of Tech., Pasadena. Dept. of Environmental Engineering Science.
J. M. Waldman, and M. R. Hoffmann.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 79-129, 15 fig, 5 tab, 104 ref.

Descriptors: *Aerosols, *Path of pollutants, *Fog, *Clouds, *Air pollution, *Water pollution sources, Sulfates, Nitrates, Ammonia, Deposition, Theoretical analysis, Water pollution control, Air-water interfaces, San Joaquin Valley, California, Particulate matter.

Droplet deposition during fog is shown to play an important role in the removal of anthropogenic pollutants from the atmosphere. Relevant theoretical principles are reviewed. The in-cloud scavenging of aerosols and soluble gases coupled with the small size of fog droplets results in higher chemical

concentrations in fog water than in rainwater. In the urban regions of southern California and the southern San Joaquin Valley, fog water chemistry is dominated by sulfate, nitrate, and ammonium ions, which are measured at millimolar levels. The formation of fog is shown to accelerate deposition rates for water-scavenged atmospheric constituents. During stagnation episodes, pollutant removal by ventilation of valley air requires at least 5 days, while the enhancement of deposition by fog formation leads to pollutant lifetimes on the order of 6-12 hours. Thus, in an environment characterized by flat, open landscape and low wind speed, droplet sedimentation can be the dominant removal mechanism of pollutants during prolonged stagnation episodes with fog. (See also W88-09065) (Author's abstract)
W88-09069

AIR-SEA TRANSFER OF TRACE ELEMENTS,
Rhode Island Univ., Kingston. Graduate School of Oceanography.
R. Arimoto, and R. A. Duce.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 131-150, 6 fig, 3 tab, 34 ref.

Descriptors: *Trace elements, *Air-water interfaces, *Path of pollutants, *Aerosols, *Pacific Ocean, Atolls, Air pollution, Aluminum, Scandium, Sedimentary cycle, Heavy metals, Manganese, Iron, Cobalt, Cesium, Barium, Cerium, Europium, Hafnium, Tantalum, Lead, Zinc, Copper, Selenium, Cadmium, Thorium, Marine sediments.

At Enewetak Atoll in the tropical North Pacific, the atmospheric concentrations of Al, Sc, Mn, Fe, Co, Cs, Ba, Ce, Eu, Hf, Ta, and Th are at times dominated by mineral aerosols from Asia. Present rates of air-sea transfer for several elements representative of mineral aerosols are similar to their rates of accumulation in sediments over the past 5000-10,000 years. This similarity implies that the air-sea transfer of particles is tied to the sedimentary cycle. The atmospheric concentrations of Pb, Zn, Cu, Se, and Cd are higher than those expected from mineral or sea salt aerosols. For these enriched elements, a comparison of air-sea transfer rates with their estimated inputs to surface water from vertical mixing shows that air-sea transfer processes also affect the chemistry of reactive trace elements in the ocean. (See also W88-09065) (Author's abstract)
W88-09070

MECHANISMS CONTROLLING THE DISTRIBUTION OF TRACE ELEMENTS IN OCEANS AND LAKES,
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 2H.
W88-09071

HYDROPHOBIC ORGANIC COMPOUNDS ON SEDIMENTS: EQUILIBRIA AND KINETICS OF SORPTION,
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
A. W. Elzerman, and J. T. Coates.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 263-317, 12 fig, 3 tab, 137 ref.

Descriptors: *Organic compounds, *Sediments, *Sorption, *Mathematical models, *Path of pollutants, *Fate of pollutants, *Kinetics, Polychlorinated biphenyls, Pesticides, DDT, Aromatic compounds, Hydrologic models, Bottom sediments, Suspended sediments, Thermodynamics, Partition coefficients, Model studies.

Modeling the fate and distribution of hydrophobic compounds in aquatic environmental systems has received considerable attention. Hydrophobic organic compounds are relatively insoluble, nonpolar compounds that have large octanol-water partition coefficients (log K(ow) > 2). A number of pollutants of interest are hydrophobic compounds such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and the DDT group of pesticides. Hydrophobic compounds tend to have large partition coefficients onto suspended and bottom sediments in aquatic systems, a factor resulting in significant effects on their distribution, fate, and effects. This chapter examines the empirical, conceptual, and mechanistic knowledge that has developed concerning sorption of hydrophobic compounds onto sediments. Thermodynamic and kinetic models are examined in an attempt to understand the basis for current practical approaches and theoretical concepts. Estimation procedures and the development of generalized evaluative approaches are emphasized. (See also W88-09065) (Author's abstract)
W88-09075

ROLE OF PARTICULATE MATTER IN THE MOVEMENT OF CONTAMINANTS IN THE GREAT LAKES,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
B. J. Eadie, and J. A. Robbins.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 319-364, 27 fig, 3 tab, 76 ref.

Descriptors: *Great Lakes, *Particulate matter, *Organic compounds, *Resuspension, *Pollutant cycling, *Paleolimnology, *Pollution histories, *Lead, *Path of pollutants, *Adsorption, Water column, Chlorinated hydrocarbons, Mixing, Radioisotopes, Pesticides, Lake sediments, Hydrologic models, Sediment transport, Bioturbation, Sediment focusing, Fate of pollutants, Sedimentation.

Particle-contaminant interactions and subsequent behavior of the particulate matter control the long-term concentration of many compounds in aquatic systems. Even in deep systems such as the Great Lakes, particle settling times from the water column are less than 1 year. After reaching the bottom, contaminant-laden particles are redistributed by episodic cycles of resuspension and redeposition, resulting in focusing, which is the spatially inhomogeneous distribution of contaminants in sediments. Bioturbation, coupled with focusing, provides source material to the resuspendible pool. The combination of these processes mediates both the composition and long-term behavior of contaminants in these lakes. (See also W88-09065) (Author's abstract)
W88-09076

SEDIMENTS AS ARCHIVES OF ENVIRONMENTAL POLLUTION TRENDS,
Indiana Univ., Bloomington. School of Public and Environmental Affairs.
M. J. Charles, and R. A. Hites.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 365-389, 11 fig, 71 ref.

Descriptors: *Lake sediments, *Core logging, *Pesticides, *Heavy metals, *Pollutant cycling, *Paleolimnology, *Pollution histories, *Path of pollutants, Polychlorinated biphenyls, Hazardous materials, Bottom sediments, Great Lakes, Dioxin, Mercury, Lead, Aromatic compounds, Hydrogen ion concentration, Air pollution, Carbon, Fate of pollutants, Water pollution sources.

Retrospective measurements of dated sediment cores can be used to determine the effect of regulations to control environmental inputs of hazardous chemicals. Sediment cores have been used to reconstruct histories of environmental contamination by mercury, lead, polycyclic aromatic hydrocarbons (PAHs), dioxins, polychlorinated biphenyls (PCBs), DDT, octachlorostyrene, pH, and carbon particles. These measurements have shown that most anthropogenic chemicals first appeared in sediments at the turn of the century at the time of the industrial revolution in most of North America. Industrial growth after World War II also resulted in inputs of pollutants such as PCBs and dioxins. Recent decreases in the levels of several contaminants may have occurred because of environmental awareness and the onset of environmental regulations. Inputs of banned pollutants continue, however, because of recycling of contaminants in the environment and long-range atmospheric transport. (See also W88-09065) (Author's abstract)
W88-09077

CHEMICAL LIMNOLOGY OF NONPOLAR ORGANIC CONTAMINANTS: POLYCHLORINATED BIPHENYLS IN LAKE SUPERIOR,
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
S. J. Eisenreich.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 393-469, 23 fig, 12 tab, 145 ref.

Descriptors: *Limnology, *Organic compounds, *Polychlorinated biphenyls, *Resuspension, *Fate of pollutants, *Water pollution sources, *Path of pollutants, *Great Lakes, Sorption, Organic matter, Organic carbon, Sediment transport, Air-water interfaces, Bottom sediments, Suspended solids, Hydrologic models, Air pollution, Fate of pollutants, Lake Superior.

The detailed aquatic behavior of polychlorinated biphenyls (PCBs) in Lake Superior permits an evaluation of the chemical limnology and environmental fate of nonpolar organic contaminants having similar physicochemical properties in large lakes. The range of physicochemical properties (e.g., Henry's law constant K(H) and the octanol-water partition coefficient K(ow)) describing the fate of the 50-100 PCB congeners observed in the environment suggests that air-water and sediment-water transport processes dominate their aquatic behavior. PCBs likely enter the lake during intense episodes of precipitation (scavenging of particles) and are subsequently lost during longer periods of volatilization. Decreasing inputs and water column concentrations suggest that the atmosphere is now a sink for PCBs previously deposited. Resuspension of bottom sediment and pore water containing PCBs dominate internal cycling. Sorption and subsequent removal of particles to the bottom are important lake detoxification processes. The observed inverse relationship of log K(p), where K(p) is the partition coefficient, and log SS, where SS is suspended solids, may be explained by mixed-particle populations of differing organic carbon content and binding of PCBs to colloidal organic matter. The estimated residence time of PCBs in Lake Superior implies an efficient removal process. A dynamic mass balance model using a new PCB input function driven by atmospheric concentrations adequately predicts observed water column concentrations. (See also W88-09065) (Author's abstract)
W88-09078

FATE OF SOME CHLOROBENZENES FROM THE NIAGARA RIVER IN LAKE ONTARIO,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
B. G. Oliver.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 471-489, 4 fig, 9 tab, 58 ref.

Descriptors: *Chlorinated hydrocarbons, *Benzenes, *Great Lakes, *Fate of pollutants, *Bioaccumulation, Fish, Invertebrates, Sedimentation, Lake sediments, Bottom sediments, Water pollution effects, Rivers, Physical properties, Industrial wastes, Lake Ontario, Niagara River, Benthos.

Pollution of the Niagara River with chemical wastes has led to severe contamination of Lake Ontario. This chapter discusses the behavior of five chlorobenzenes in the Niagara River, in the river plume, and in Lake Ontario. The importance of sedimentation and volatilization on chemical pathways in the lake has been assessed. Bottom sediments are shown to contain the bulk of the chlorobenzenes that remain in the lake. The physical processes that affect the concentration distribution of chlorobenzenes in bottom sediments are explained, together with processes that affect the desorption rates of chlorobenzenes from sediments and biouptake of chlorobenzenes by benthic invertebrates. The contamination of fish and other biota is reported, and contaminant trends in sediment

cores and biota are discussed. (See also W88-09065) (Author's abstract)
W88-09079

CYCLES OF NUTRIENT ELEMENTS, HYDROPHOBIC ORGANIC COMPOUNDS, AND METALS IN CRYSTAL LAKE,
Wisconsin Univ.-Madison. Water Chemistry Program.
D. E. Armstrong, J. P. Hurley, D. L. Swackhamer, and M. M. Shafer.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 491-518, 6 fig, 5 tab, 48 ref.

Descriptors: *Cycling nutrients, *Organic compounds, *Metals, *Lakes, *Path of pollutants, *Particulate matter, Suspended sediments, Lead, Iron, Carbon, Nitrogen, Phosphorus, Silicon, Polychlorinated biphenyls, Geochemistry, Lake sediments, Sediment-water interfaces, Crystal Lake, Wisconsin.

Measurements of the chemical composition and fluxes of particulate matter were used to assess the particle-mediated cycling of selected nutrient elements, hydrophobic organic compounds, and metals in Crystal Lake, located in north central Wisconsin. The absence of surface water input simplified the analysis of in-lake cycles. Sediment incorporation and accumulation fluxes were calculated on the basis of an assumption of negligible sediment focusing. Removal of Pb210 was rapid with negligible recycling, and Po210 was partly recycled in the water column. The nutrient elements (C, N, P, and Si) contained in deposited particles were partly recycled (approximately 50%) into the water column, but most of the P recycled was subsequently redeposited through interaction with Fe(III) formed near the sediment-water interface. Hydrophobic organic compounds such as polychlorinated biphenyls (PCBs) were also removed rapidly to the sediment-water interface by particle deposition but apparently returned partly to the water column during particle incorporation into surface sediments. Although PCBs were partly returned to the sediments by redeposition, recycling from bottom sediments increased the residence time of PCBs in the water column. Differences among chemical constituents in particle-mediated fluxes were regulated by differences in biogeochemical processes. (See also W88-09065) (Author's abstract)
W88-09080

PESTICIDES: MINIMIZING THE RISKS.
For primary bibliographic entry see Field 5C.
W88-09082

PRINCIPLES GOVERNING ENVIRONMENTAL MOBILITY AND FATE,
California Univ., Davis. Dept. of Environmental Toxicology.
J. N. Seiber.
IN: Pesticides: Minimizing the Risks. American Chemical Society, Washington, DC. ACS Symposium Series 336. 1987. p 88-105, 1 fig, 4 tab, 40 ref.

Descriptors: *Fate of pollutants, *Pesticides, *Mathematical models, *Path of pollutants, *Leaching, *Bioaccumulation, Physicochemical properties, Leachates, Mathematical studies, Biological magnification, Prediction, Model studies, Pesticide kinetics, Air pollution, Adsorption.

During the past several years, much attention has been devoted to understanding the physical and chemical properties, processes, and principles governing the environmental behavior and fate of chemicals. The goal is to be able to predict how chemicals behave before release occurs and to use this capability in the design and regulation of chemicals proposed for use in pest control and other environmental applications. This effort has included improving the data base of key physical and chemical properties, understanding the processes which underlie movement to air, biota, and groundwater, and developing models for predicting mobility and persistence. The modelling approach is illustrated with examples of pesticide volatilization from water and the fate of pesticides in aquatic field use situations. The role of field experiments in validating predictive models is also discussed. (See also W88-09082) (Author's abstract)
W88-09083

EVALUATION OF PESTICIDES IN GROUND WATER.
American Chemical Society, Washington, DC. ACS Symposium Series 315. Developed from a symposium sponsored by the Division of Pesticide Chemistry at the 189th Meeting of the American Chemical Society, Miami Beach, Florida, April 28-May 3, 1985. 1986. Edited by Willa Y. Garner, Richard C. Honeycutt, Herbert N. Nigg. 573 p.

Descriptors: *Pesticides, *Fate of pollutants, *Path of pollutants, *Groundwater pollution, *Groundwater, Agricultural chemicals, Monitoring, Pesticides, Model studies, Case studies, Toxicity, Sorption, Degradation, Legal aspects.

Aspects of the factors that impinge on groundwater contamination from agriculturally applied pesticides are described in papers presented at the symposium sponsored by the Division of Pesticide Chemistry at the 189th meeting of the American Chemical Society. Topics covered include physical and chemical parameters, groundwater monitoring techniques, field and laboratory groundwater monitoring, modeling and model validation, risk assessment and its toxicological significance, and regulatory aspects. Spatial variability of pesticide sorption and degradation parameters, soil characteristics affecting pesticide movement into groundwater, reproductive and developmental toxicity risk assessment, safety evaluation of pesticides in groundwater, and fate of aldicarb in Wisconsin groundwater were detailed. Other topics discussed included complexity of contaminant dispersal in a karst geological system, 1,2-dibromoethane in two soil profiles, case studies of two groundwater contamination problems, and risk, uncertainty and the legal process. (See W88-09090 thru W88-09119) (See also W88-09089) (Wood-PTT)
W88-09089

PROCESSES AND FACTORS AFFECTING TRANSPORT OF PESTICIDES TO GROUND WATER,
Washington State Univ., Pullman. Dept. of Agronomy and Soils.
H. H. Cheng, and W. C. Koskinen.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 2-13, 2 fig, 47 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Path of pollutants, *Soil contamination, *Groundwater pollution, *Groundwater, Soil profiles, Pollutants, Vadose water, Soil horizons, Sorption, Degradation.

The process of transporting pesticides down through the soil horizons and vadose zone into the groundwater is affected by a number of other processes taking place in the soil profile. The sorption process can retard or retain the chemicals from moving with leaching water. The commonly used pesticides, mostly being organic chemicals, can be degraded partially or completely to inorganic end products by chemical, photochemical, or biochemical means. The degradation processes reduces or eliminates the presence of pesticides in the environment. Pesticides can also be transported to the atmosphere by volatilization or to surface water by runoff from soil, or be removed from soil by plant uptake. Whether circumstances for transport of pesticides to groundwater exist will depend upon a combination of factors including the nature of the pesticide chemical, the properties and conditions of the soil, and climatic and environmental variables. Realistic assessment of the potential for transport of pesticides to groundwater must include simultaneous evaluation of all the processes and factors that may impact the transport process. (See also W88-09089) (Author's abstract)
W88-09090

SOIL CHARACTERISTICS AFFECTING PESTICIDE MOVEMENT INTO GROUND WATER,
Agricultural Research Service, Beltsville, MD.
C. S. Helling, and T. J. Gish.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 14-38, 5 fig, 4 tab, 77 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Path of pollutants, *Soil contamination, *Groundwater pollution, *Groundwater, *Soil properties, Pollutants, Adsorption, Desorption, Degradation, Volatility, Runoff, Plant uptake, Model studies, Mathematical equations, Atrazine, Leaching.

Processes that modify convective transport of pesticides through soil and into groundwater include adsorption/desorption, degradation, volatilization, runoff, and plant uptake. These processes, in turn, are affected by soil characteristics, climate, pesticide properties, and agricultural practices. A screening model based on the convection-dispersion equation (assuming 1st-order degradation) was used to rank several soil properties that may affect atrazine leaching. Transport was most retarded by low hydraulic conductivity and high soil organic matter content; increased bulk density attenuated leaching to a lesser extent. A literature survey, with emphasis on atrazine, aldicarb, and DBCP (pesticides that have leached to groundwater), tended to confirm that sandy soils (with high hydraulic conductivity and low organic matter) were usually associated with leaching. Restricted drainage led to lateral subsurface movement or occurrence of residues in perched groundwater. At the other extreme, karst topography allowed rapid recharge and high probability of pesticide leaching. (See also W88-09089) (Author's abstract)
W88-09091

DETERMINING UNCERTAINTY IN PHYSICAL PARAMETER MEASUREMENTS BY MONTE CARLO SIMULATION,
Research Triangle Inst., Research Triangle Park, NC.
D. W. Coy, G. A. Kew, M. E. Mullins, and P. V. Piserchia.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 39-60, 9 fig, 2 tab, 20 ref.

Descriptors: *Chemical transport, *Statistical methods, *Monte Carlo method, *Path of pollutants, *Physical properties, *Data interpretation, *Errors, Pollutants, Mathematical studies, Statistics, Mathematical equations, Vapor pressure, Solubility.

A statistical approach, often called Monte Carlo simulation, was used to examine propagation of error and to better characterize the uncertainty associated with measurement of several parameters important in predicting environmental transport of chemicals. These parameters are vapor pressure, water solubility, octanol-water partition coefficient, and 'volatilization from water' (based on the ratio of laboratory-measures volatilization from water' (based on the ratio of laboratory-measured volatilization rate constant to oxygen reaeration rate constant for a specific system). Column chromatographic and high pressure liquid chromatographic (HPLC) methods are replacing more traditional equilibrium methods (e.g. shake flask, isoteniscope) for measuring the first three parameters. The newer methods tend to underpredict aqueous solubility and vapor pressure and overpredict octanol-water partition coefficient, although deviations for both the equilibrium and dynamic systems are similar. Measurement error proves not to be normally distributed, with differing bias for each parameter. For 'volatilization from water', determinations of the ratio of rate constants for compounds whose Henry's Law constant equals or exceeds 1,000 torr/mole/liter typically report 95% confidence limits equal to 5 to 10% of the ratio. Analysis of a regression approach often used to determine the ratio suggests underestimation of both ratio and its variances. Monte-Carlo simulation did confirm underestimation of the ratio but suggests variances may be underestimated by a

factor of 2.3. Using this statistical approach in other cases might allow an investigator to choose levels of a parameter (e.g. drinking water standard) knowing the uncertainty associated with the choice, or the converse. (See also W88-09089) (Author's abstract)
W88-09092

QUANTIFYING PESTICIDE ADSORPTION AND DEGRADATION DURING TRANSPORT THROUGH SOIL TO GROUND WATER,
Cornell Univ., Ithaca, NY. Coll. of Human Ecology.
W. Z. Zhong, A. T. Lemley, and R. J. Wagenet.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 61-77, 4 fig, 5 tab, 18 ref.

Descriptors: *Pesticides, *Pesticide transport, *Adsorption, *Degradation, *Fate of pollutants, *Path of pollutants, *Experimental design, *Soil contamination, *Groundwater pollution, Groundwater, Pollutants, Model studies, Mathematical equations, Aldicarb, Soil columns.

A rapid experimental method and a basis for analyzing the results are described that will allow quantitative determination of pesticide adsorption and degradation during displacement through soil. A soil column methodology employing commercially available equipment developed for high-pressure liquid chromatography studies was used to investigate the movement and transformation of aldicarb, aldicarb sulfoxide and aldicarb sulfone. Analytical solutions to the convection-dispersion equation that included description of linear adsorption and first-order transformation were used to interpret the data. Experiments were conducted in two soils, at two flow velocities, in sterile and nonsterile conditions, and at two initial influent concentrations to demonstrate the usefulness of the method and to define the adsorption and microbial and chemical conversion of aldicarb better. The apparent diffusion coefficient was determined for the particular leaching conditions in each of the thirteen experiments using the measured chloride breakthrough curve and derived equations. Analytical solutions to transport equations that consider adsorption and pesticide transformation simultaneously, when used in concert with appropriate soil column techniques, offer substantial promise for the study of the fate of organic chemicals in the environment. The method presented provides a protocol which can be generalized for the study of any pesticide in soil. (See also W88-09089) (Wood-PTT)
W88-09093

GEOHYDROLOGY OF A FIELD SITE: STUDY OF PESTICIDE MIGRATION IN THE UNSATURATED AND SATURATED ZONES OF DOUGHERTY PLAIN, SOUTHWEST GEORGIA,
Geological Survey, Doraville, GA. Water Resources Div.
S. C. Cooper.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 78-99, 8 fig, 1 tab, 22 ref.

Descriptors: *Path of pollutants, *Pesticides, *Pesticide transport, *Fate of pollutants, *Soil contamination, *Groundwater pollution, *Groundwater, Saturated soils, Aeration zone, Geohydrology, Pollutants, Aldicarb, Georgia, Leaching, On-site investigations.

A 10-acre area of a peanut field in southeastern Lee County, Georgia, was selected to investigate the migration of the pesticide aldicarb in the unsaturated and saturated zones, and to assess the potential for degradation of the groundwater resource. The hydrogeologic framework was determined from sample cuttings, a continuous core, and geophysical logs obtained from test wells drilled in the field, and from bimonthly and continuously recorded water-level measurements. The study site is underlain, in descending order, by the undifferentiated residuum, which forms the water table aquifer, and by the Ocala Limestone, the Clinchfield Sand, and the Lisbon Formation of Eocene age, which form the Upper Floridan aquifer. Geohydrologic data indicate that in the area of the study site, the Upper Floridan aquifer consists of an upper and a lower permeable zone; the upper permeable zone is hydraulically connected to the water table aquifer. Precipitation entering the residuum generally moves downward and recharges the Upper Floridan aquifer. Water recharging the Upper Floridan aquifer moves laterally downgradient to points of natural discharge and to pumping centers. Because of the hydraulic connection between the residuum and the Upper Floridan aquifer, the potential exists for pesticides to migrate into the groundwater system. (See also W88-09089) (Author's abstract)
W88-09094

SPATIAL VARIABILITY OF PESTICIDE SORPTION AND DEGRADATION PARAMETERS,
Florida Univ., Gainesville. Dept. of Soil Science.
P. S. C. Rao, K. S. V. Edvardsson, L. T. Ou, R. E. Jessup, and P. Nkedi-Kizza.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 100-115, 6 fig, 2 tab, 41 ref.

Descriptors: *Pesticides, *Pesticide transport, *Path of pollutants, *Fate of pollutants, *Soil contamination, *Sorption, *Degradation, Pollutants, Florida, Georgia, Spatial variability, Soil properties, Organic carbon.

Data were collected at two field sites, one in Florida and the other in Georgia, to evaluate the variability in pesticide concentrations and in pesticide sorption and degradation parameters. The observed variability can be attributed to intrinsic factors resulting in imposed variability. Data are presented to demonstrate the predominant effects of the method of pesticide application and tillage operations in introducing significant extrinsic variability in pesticide concentrations. Variability introduced at the soil surface may persist as the pesticide leaches to deeper depths. At both field sites, a close relationship was found between the spatial variations in soil organic carbon content and pesticide sorption coefficients. At the Georgia field site, small variations (coefficient of variation $< 30\%$) were noted in measured pesticide degradation half-lives in soil samples collected from several locations and four morphologic horizons. Spatial patterns in pesticide sorption and degradation parameters did not correspond to spatial boundaries of the soil series. (See also W88-09089) (Author's abstract)
W88-09095

APPLICATIONS OF SURFACE GEOPHYSICAL METHODS TO GROUND WATER POLLUTION INVESTIGATIONS,
Weston (Roy F.), Inc., Edison, NJ. Raritan Center.
For primary bibliographic entry see Field 7B.
W88-09096

DRASTIC: A SYSTEM TO EVALUATE THE POLLUTION POTENTIAL OF HYDROGEOLOGIC SETTINGS BY PESTICIDES,
National Water Well Association, Worthington, OH.
L. Aller, T. Bennett, J. H. Lehr, and R. Petty.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 141-158, 3 fig, 10 tab, 15 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Geohydrology, *Groundwater pollution, *Data interpretation, Pollutants, Evaluation, Prediction.

A methodology is described which allows the pollution potential of any area to be systematically evaluated anywhere in the United States. The system, which optimizes the use of existing data, has two major portions: the designation of mappable units, termed hydrogeologic settings, and the superposition of a relative ranking system called DRASTIC. Hydrogeologic settings incorporate the major hydrogeologic factors which are used to infer the potential for pesticides to enter groundwater. These factors, which form the acronym DRASTIC, include depth to water, net recharge, aquifer media, soil media, topography, impact of the vadose zone and hydraulic conductivity of the aquifer. The relative ranking scheme uses a combination of weights and ratings to produce a numerical value, called the DRASTIC Index, which helps prioritize areas with respect to pollution potential. (See also W88-09089) (Author's abstract)
W88-09097

HYDROGEOLOGIC INVESTIGATIONS OF PESTICIDE SPILLS,
Geraghty and Miller, Inc., Tampa, FL.
R. E. Moon, and C. D. Henry.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 159-168, 2 tab, 7 ref.

Descriptors: *Pesticides, *Pesticide transport, *Path of pollutants, *Groundwater pollution, *Monitoring wells, *Geohydrology, Water pollution, Pollutants, Monitoring, Wells, Drilling.

Groundwater contamination by pesticides occurs under two distinct situations arising either from widespread agricultural use of from a specific point source loss. Point source loss of pesticides or spills, which are generally associated with the manufacture or disposal of pesticides, were studied. The groundwater contamination commonly stems from leaky pipes, used drums, lagoons, landfills, and with streams on plant property. Hydrogeologic investigation is conducted to identify the vertical and horizontal extent of contamination so that ultimately the contamination can be isolated and the aquifer remediated. The regulatory and hydrologic requirements of a monitoring plan consist of four basic elements: problem identification, health and safety requirements, monitor-well network design, and drilling and well-installation techniques. Suggestions for identifying the pollution problem including review of the site history, geology and hydrogeology, definition of previous waste disposal practices and those of adjacent sites, and field reconnaissance with various techniques are presented. The design of a monitoring well network and the methods available for the drilling and installation of monitoring wells are detailed. (See also W88-09089) (Wood-PTT)
W88-09098

MONITORING GROUND WATER FOR PESTICIDES,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
S. Z. Cohen, C. Eiden, and M. N. Lorber.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 170-196, 1 fig, 1 tab, 68 ref.

Descriptors: *Pesticides, *Water quality control, *Monitoring, *Path of pollutants, *Groundwater pollution, Water pollution, Pollutants, Monitoring wells, Agricultural chemicals, Sampling, Water sampling, Soil sampling, Data collections.

At least 17 pesticides have been found in groundwater in a total of 23 states as a result of agricultural practice. These results were obtained through three different types of monitoring studies: (1) large-scale retrospective; (2) small-scale retrospective; and (3) small-scale prospective. Retrospective studies survey areas where the pesticide(s) in question has already been used. Prospective studies involve intensive field investigation in which the pesticide is applied and monitoring begins at time zero. Often, soil core data are at least as important as groundwater data. The ability to draw meaningful conclusions from large-scale studies is greatly diminished unless the studies have a statistical, stratified design. The three study types are described, and soil sampling and well construction guidelines are suggested. A summary of data on pesticides found in groundwater as a result of agricultural practice classified by pesticide type, number, amount and location in the states is presented. Findings on Alachlor, Aldicarb, Atrazine, Bromacil, Carbofuran, Cyanazine, DBCP, DCPA, 1,2-Dichloropropane, Dinoseb, Dyfonate, EDB,

Metolachlor, Metribuzin, Oxamyl, Simazine, and Trichloropropane were reviewed in detail. (See also W88-09089) (Wood-PTT)
W88-09099

FIELD, LABORATORY, AND MODELING STUDIES ON THE DEGRADATION AND TRANSPORT OF ALDICARB RESIDUES IN SOIL AND GROUND WATER,
Union Carbide Agricultural Products Co., Inc., Research Triangle Park, NC.
R. L. Jones.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 197-218, 4 fig, 3 tab, 26 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Carbamate pesticides, *Path of pollutants, *Aldicarb, *Soil contamination, *Groundwater pollution, Degradation, Saturation zone, Aeration zone, Soil properties, Model studies, Groundwater movement.

Research conducted on the movement and degradation of aldicarb residues in the unsaturated and saturated zones showed that it is a complex process affected by soil and hydrogeological properties, climatic conditions, and agricultural practices. The results are presented of unsaturated and saturated zone field studies conducted in 16 states over a period of six years in which approximately 20,000 soil and water samples were collected. Results from laboratory degradation studies are also included. Computer modeling was used to illustrate the effects of variables such as soil field capacity, soil organic matter, pesticide application timing, and climatic conditions on the potential for aldicarb residues to reach groundwater. These experimental and modeling studies show that in most areas aldicarb residues degrade in the upper portion of the unsaturated zone. In the relatively few areas where aldicarb residues reach groundwater, the primarily lateral movement of groundwater and the continuing degradation usually limit the presence of aldicarb residues to shallow groundwater near treated fields. (See also W88-09089) (Author's abstract)
W88-09100

FATE OF ALDICARB IN WISCONSIN GROUND WATER,
Wisconsin Univ.-Madison. Dept. of Soil Science.
J. M. Harkin, F. A. Jones, R. N. Fathulla, E. K. Dzantor, and D. G. Kroll.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 219-255, 8 fig, 10 tab, 46 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Path of pollutants, *Carbamate pesticides, *Aldicarb, *Groundwater pollution, *Groundwater movement, Degradation, Agricultural chemicals, Sand, Leaching, Seasonal variation, Hydrolysis, Water temperature, Model studies, Mathematical models, Wisconsin, Sensitivity analysis.

Small amounts of aldicarb sulfoxide and sulfone leach through sandy soils to shallow groundwater in Central Wisconsin fields where aldicarb is applied to irrigated potatoes. Leachate residue concentrations decrease with application rates and later application time. The pattern of leaching through soil and the levels detectable in groundwater are invariably highly erratic. Leaching occurs mainly during the late summer and fall of years of application; highest residue concentrations in groundwater occur later in a zone near the water table. These levels dissipate as this zone is overlain with uncontaminated leachate, but residues disappear at rates faster than can be ascribed to dilution and dispersion due to natural groundwater movement. The groundwater movement is complicated by water table fluctuations and flow perturbation caused by water extraction for irrigation. Residue attenuation is apparently accelerated by hydrolysis in the alkaline groundwater and degradation by a variety of groundwater-inhabiting bacteria. The groundwater alkalinity increases with depth and fluctuates seasonally, rising in summer with CO2 in the water, which dissolves dolomitic limestone in the aquifer sediments. Rates of breakdown presumably vary with the groundwater temperature, which ranges from 3-4 C in February-March to 20-21 C in August near the water table but remains at 12-14 C 10 m deep in the aquifer. This complex interplay of factors prevents accurate prediction of the fate of aldicarb residues in the groundwater by mathematical modeling on the basis of available data. Sensitivity analysis indicates that degradation rates are the crucial determinant of occurrence and persistence in groundwater. (See also W88-09089) (Author's abstract)
W88-09101

COMPLEXITY OF CONTAMINANT DISPERSAL IN A KARST GEOLOGICAL SYSTEM,
Pennsylvania State Univ., University Park. Dept. of Entomology.
D. A. Kurtz, and R. R. Parizek.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 256-281, 11 fig, 3 tab, 7 ref.

Descriptors: *Path of pollutants,*Fate of pollutants, *Karst, *Karst hydrology, *Groundwater movement, *Groundwater pollution, Pollutants, Groundwater, Aquifers, Pennsylvania, Subsurface water, Water pollution, Flow discharge, Geohydrology.

The various means of dispersal of environmental contaminants within folded and faulted carbonate (karst) rocks that define a complex karst aquifer system of the Central Appalachian type include surface and subsurface pathways. Chemicals may be exchanged among surface water, soilwater, and groundwater flow systems. Concentrations of a marker compound found in spring waters, surface waters of a creek, and groundwater pumped from wells located adjacent to the creek illustrate these exchange processes. Water from residential wells grouped near each other and located downstream from a waste-disposal site contained the marker compound at different levels ranging from 5 to 22 ppt in 1984. Concentrations found in 1977/78 were similar to those found in 1984 in some houses but were different in others. Evidence is presented that show barriers to subsurface water flow exist in the form of geological structures, of subsurface water table divides and gradient directions, and of water flows within groundwater basins of various sizes, all of which channel the potential flow of contaminants and limit dispersion possibilities. The contaminant may have entered the more regional carbonate aquifers by natural streambed leakage, by infiltration induced by groundwater pumpage, or by nearby sewage sludge disposal. (See also W88-09089) (Author's abstract)
W88-09102

1,2-DIBROMOETHANE (EDB) IN TWO SOIL PROFILES,
California Dept. of Food and Agriculture, Sacramento.
D. W. Duncan, and R. J. Oshima.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 282-293, 3 fig, 6 tab, 15 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Path of pollutants, *Soil contamination, *Groundwater pollution, *Ethylene dibromide, *Soil profiles, Statistical analysis, Organic carbon, Soil properties.

Soil properties and Ethylene Dibromide (EDB) concentrations were measured at two locations with histories of EDB applications. The objective was to explain the presence of EDB residues in a well near one location and the lack of residues in a well near the other location. The soil profile was sampled at each location from the surface to groundwater, and groundwater samples were collected at the profile base. A combination of statistical analyses (stepwise linear regression and discriminant analyses) was applied to soil data to interpret differences within each location. Maximum EDB concentrations were found at location 1 between 0 and 0.98 meters and ranged from 0.3 to 12.5 ppb, correlating with organic carbon. Location 1, composed of a silty clay, contained a deeper band of EDB lying between 2.35 and 2.98 meters below soil surface. Within the band, EDB concentrations ranged from 0.2 to 0.6 ppb. The presence of this deeper band was not correlated with any measured variables, including organic carbon, and may represent migrating EDB. The fumigant was found between 0 and 0.46 meters at location 2 and was correlated with organic carbon. EDB was not found in deeper soil layers of location 2, which was characterized as a more coarsely textured soil than location 1. Depth to groundwater was 5.2 and 4.0 meters at locations 1 and 2 respectively, and EDB was not detected in water sampled at the profile bases. (See also W88-09089) (Author's abstract)
W88-09103

CHEMICAL AND MICROBIAL DEGRADATION OF 1,2-DIBROMOETHANE (EDB) IN FLORIDA GROUND WATER, SOIL, AND SLUDGE,
Florida Univ., Gainesville. Pesticide Research Lab.
R. A. Weintraub, G. W. Jex, and H. A. Moye.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 294-310, 10 fig, 2 tab, 29 ref.

Descriptors: *Pesticides, *Fate of pollutants, *Soil contamination, *Groundwater pollution, *Degradation, *Sludge, *Chemical degradation, *Microbial degradation, *1,2-Dibromoethane, Chemical half-life, Pollutants, Florida, Temperature effects, Hydrolysis.

The chemical and microbial degradation of 1,2-dibromoethane (EDB) in the subsurface environment was studied in laboratory incubations of groundwater, soil suspensions and sludge suspensions. EDB was determined to have a chemical half-life of 1.5 to 2 years in Florida groundwaters (22 C). Rate constants for degradation determined at elevated temperatures were used to obtain extrapolated values via Arrhenius kinetics. Hydrolysis is the major mode of degradation, giving ethylene glycol and bromide ion, and is not pH-dependent between pH 4 and 9. Formaldehyde, an oxidation product of ethylene glycol, was shown to be a degradation product during extended incubation at elevated temperatures. Concentrations of 1 to 2 ppm of EDB were anaerobically degraded to ethylene by either methanogenic or facultative sludge in about 60 days, whereas Florida soils examined were nearly incapable of degrading EDB under these conditions. (See also W88-09089) (Author's abstract)
W88-09104

MOVEMENT OF SELECTED PESTICIDES AND HERBICIDES THROUGH COLUMNS OF SANDY LOAM,
Acurex Corp., Mountain View, CA.
V. Lopez-Avila, P. Hirata, S. Kraska, M. Flanagan, and J. H. Taylor.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 311-328, 10 fig, 3 tab, 24 ref.

Descriptors: *Pesticides, *Pesticide transport, *Soil types, *Loam, *Path of pollutants, *Herbicides, *Leaching, *Groundwater pollution, Lysimeters, Leaching, Leachates, Adsorption.

Several available models simulating mobility of chemicals through soils are currently being evaluated by the Environmental Protection Agency-Las Vegas by conducting a laboratory experiment in which lysimeter columns containing test chemicals at levels corresponding to agricultural rates are irrigated with water at a constant rate for 30 days. Leachate samples collected daily from the lysimeter columns and soil cores obtained at the completion of the experiment are analyzed for the test chemicals. The observed concentrations are compared with the model predictions. However, prior to initiation of the actual lysimeter experiments, a small-scale experiment using 3 columns 4.8 cm ID by 50 cm height was performed to establish breakthrough volumes of the test chemicals, to ascertain whether the selection of the test chemical was

appropriate, and to determine if the analytical methods were adequate. The six chemical selected were: dicamba, 2,4-D, atrazine, diazinon, pentachlorophenol, and lindane. From the small-scale experiment it is observed that the distribution of the test chemicals and the order in which they were leached in the three soil columns were in excellent agreement. Good correlation between the value of the organic carbon normalized adsorption coefficient and the movement constant for atrazine, diazinon and pentachlorophenol suggests that the movement through the soil column can be predicted from adsorption data; this not the case for lindane. (See also W88-09089) (Wood-PTT)
W88-09105

PRINCIPLES OF MODELING PESTICIDE MOVEMENT IN THE UNSATURATED ZONE,
Cornell Univ., Ithaca, NY. Dept. of Agronomy.
R. J. Wagenet.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 330-341, 27 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Path of pollutants, *Model studies, *Soil contamination, *Aeration zone, Mathematical equations, Diffusion, Convection, Sorption, Degradation, Volatilization.

The basic principles of modeling the physical, chemical and biological processes that determine pesticide fate in unsaturated soil are reviewed. The mathematical approaches taken to integrate these processes, including diffusion, convection, sorption, degradation and volatilization, are presented. Deterministic and stochastic models formulated to describe these processes in a soil-water pesticide system are contrasted and evaluated. The use of pesticide models for research or management purposes dictates the degree of resolution with which these processes are modeled. The ability of each type of modeling approach to consider pesticide fate in spatially variable field systems is discussed. It is concluded that the manner in which current pesticide models should be used, the reliability of their predictions and the direction of future pesticide modeling efforts must be seriously questioned because there is every indication that the current models are not universally reliable and there is almost no proof of their credibility in the field. It is shown that no pesticide model exists that has been proven to estimate consistently and accurately the spatial and temporal distribution of pesticide concentrations in the unsaturated zone regardless of the resolution used to represent the basic principles in the model, and whether the model falls into the research or management category. It follows that current models should be used only to compare the relative, not absolute, behavior of pesticides in field soils and it is, therefore, suggested that the approach taken to modeling pesticide fate in unsaturated soils must change. It is suggested that a stochastic, rather than deterministic, approach be considered when modeling water and chemical movement in the unsaturated zone. (See also W88-09089) (Wood-PTT)
W88-09106

METHOD FOR THE ASSESSMENT OF GROUND WATER CONTAMINATION POTENTIAL: USING A PESTICIDE ROOT ZONE MODEL (PRZM) FOR THE UNSATURATED ZONE,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
M. N. Lorber, and C. K. Offutt.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 342-365, 5 fig, 8 tab, 22 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Path of pollutants, *Model studies, *Data interpretation, *Groundwater pollution, *Aeration zone, Leaching, Carbomate pesticides, Aldicarb, Groundwater, North Carolina, Wisconsin, Degradation, Simulation, Soil types, Sand, Loam, Irrigation effects.

The Pesticide Root Zone Model (PRZM) was used to evaluate the potential of aldicarb to leach through soil and contaminate groundwater in three use sites: tobacco grown on a sandy loam soil in North Carolina and potatoes grown on a sandy loam and a loamy sand in Wisconsin. Calibration with the use of field data on these sites allowed field values of aldicarb decay rate and partition coefficient to be estimated. Long term simulations then permitted evaluation of the effect of soil type, date of application, and irrigation on the leaching potential of aldicarb in these use sites. Results showed little to no potential for leaching on the sandy loam soils, but significant leaching on the loamy sand, with between 1 and 19% of applied aldicarb leaching below 2 meters, and six-month plume solution concentrations as high as 103 ppb at two meters. Application later in the season reduced leaching by about one-half, and irrigation increased leaching 3-5 times. (See also W88-09089) (Author's abstract)
W88-09107

MODELING PESTICIDE MOVEMENT IN THE UNSATURATED ZONE OF HAWAIIAN SOILS UNDER AGRICULTURAL USE,
Hawaii Univ., Honolulu. Dept. of Agronomy and Soil Sciences.
R. E. Green, C. C. K. Liu, and N. Tamrakar.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 366-383, 7 fig, 3 tab, 37 ref.

Descriptors: *Pesticides, *Pesticide transport, *Path of pollutants, *Model studies, *Groundwater pollution, *Soil contamination, *Aeration zone, *Agricultural chemicals, Leaching, Mathematical equations, Dispersion, Convection, Agronomy, Model testing, Prediction, Sorption, Hawaii.

Two instances of pesticides leaching to groundwater were examined by modeling approaches which incorporated appropriate pesticide inputs to the soil, measured pesticide sorption coefficients and water balance calculations based on actual rainfall and estimated evapotranspiration and runoff. First, an analytical model was used to examine movement of DBCP (1,2-dibromo-3-chloropropane) which was accidentally spilled near a deep well on Oahu. The model features the convective-dispersive solute transport equation with an upper boundary condition which approximates volatile losses over time from a soil layer near the surface. The second study examined DBCP movement under pineapple culture. The analysis combined a two-dimensional analytical model, to compute the time varying distribution and dissipation of DBCP in the plow layer, and a one-dimensional numerical model to simulate both water and DBCP movement in a layered profile below the surface layer. Both modeling efforts were only moderately successful in predicting pesticide concentration profiles, as evidenced by a comparison of computed and measured DBCP concentrations with depth, but the results were useful in assessing the impact of key processes and in identifying data requirements for future modeling efforts. Model calculations and laboratory experiments both showed that sorption coefficients for long-term DBCP residues were much larger than was indicated by conventional batch equilibration measurements. Thus, conventional prediction of the leaching and volatilization of DBCP residues requires a better understanding of sorption mechanisms. (See also W88-09089) (Author's abstract)
W88-09108

EVALUATION OF PESTICIDE TRANSPORT SCREENING MODELS UNDER FIELD CONDITIONS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
W. A. Jury, H. Elabd, L. D. Clendening, and M. Resketo.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 384-395, 6 fig, 2 tab, 19 ref.

Descriptors: *Pesticides, *Pesticide transport, *Path of pollutants, *Model studies, Soil contamination, Irrigation effects, Fate of pollutants, Field tests, Sprinkler irrigation, Mathematical equations, Adsorption, Leaching.

Two field experiments investigating the mobility of pesticides leached by sprinkler irrigation are discussed. In the first experiment, a pulse of chloride and napropamide, a moderately adsorbed herbicide, was applied to a 0.6 ha field in California which was subsequently leached with 25 cm of water low in chloride over a two-week period. Soil core samples were taken at 36 locations to 300 cm and were analyzed in 10 cm increments for chloride and pesticide. Approximately 80% of the pesticide recovered in the cores was found within 20 cm of the soil surface, which was consistent with the predicted behavior based on the measured distribution coefficient values. However, the remaining 20% of the pesticide was located randomly between 20 and 180 cm, suggesting that this portion of the applied chemical moved without adsorbing. In the second experiment, conducted on 14 plots at the same site, the soil surface was sprayed with a mixture of four chemicals (bromide, bromacil, napropamide and prometryn) and irrigated for two weeks by sprinkler irrigation. Field-wide leaching behavior was similar to that of the earlier experiment, with the strongly adsorbed chemicals napropamide and prometryn showing split concentration peaks in each core with most of the chemical located near the soil surface and the remainder randomly located between the surface and depths approaching those reached by bromide, the mobile chemical. It is concluded that existing chemical transport models, after calibration with laboratory distribution values, are capable of describing the location of the adsorbed portion of the chemical, but are unable to predict the location of the portion which bypasses the adsorption sites. (See also W88-09089) (Wood-PTT)
W88-09109

FIELD VALIDATION OF GROUND WATER MODELS,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
M. P. Anderson.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 396-412, 7 fig, 22 ref.

Descriptors: *Groundwater, *Pesticides, *Pesticide transport, *Path of pollutants, *Model studies, Calibrations, Case studies, Groundwater pollution, Mathematical equations, Model testing, Carbamate pesticides, Aldicarb, Wisconsin, Pollutants, Aeration zone, Path of pollutants.

Procedures for calibrating flow models and contaminant transport models are outlined and some of the difficulties frequently encountered during calibration are discussed. An example of a contaminant transport model applied to a problem involving aldicarb migration in groundwater in Wisconsin is also presented. Uncertainties in input parameters, including quantifying the source function, the degradation characteristics in the subsurface, and the heterogeneous nature of the porous material that constitutes the aquifer, often make field calibration of groundwater models difficult. The amount and concentration of contaminants entering the groundwater system depend, not only on the amount infiltrating the land surface, but also on uptake and chemical reactions occurring in the unsaturated zone so, ideally, a groundwater model should be linked to a model of the unsaturated zone. Aquifer heterogeneities influence the configuration of the velocity field and may be critical to the proper quantification of contaminant movement, but there is no consensus among researchers on the proper way to simulate dispersion of contaminants in groundwater. Modelers must confront the fact that most groundwater models are designed to simulate two-dimensional flow fields when in reality many groundwater contamination problems are three-dimensional. Groundwater flow problems can generally be simplified to two dimensions, but it appears doubtful that three-dimensional contaminant plumes can be represented adequately by two-dimensional models. The expense of collecting sufficient three-dimensional field data to validate a three-dimensional model is prohibitive for most studies. (See also W88-09089) (Wood-PTT)
W88-09110

TWO GROUND WATER CONTAMINATION PROBLEMS: CASE STUDIES,
New York State Dept. of Health, Albany. Bureau of Toxic Substance Assessment.
N. K. Kim, A. J. Grey, R. Tramontano, C. Hudson, and G. Laccetti.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 530-540, 1 tab, 15 ref.

Descriptors: *Pesticides, *Groundwater pollution, *Water pollution sources, *Path of pollutants, *Water quality control, Agricultural chemicals, Groundwater, Case studies, New York, Drinking water, Industrial wastes, Oxamyl.

In New York State, three types of chemicals are found to cause most groundwater contamination: solvents, petroleum products, and pesticides. Two different contamination scenarios involving sandy soil and pesticides are described. In Fort Edward, an investigation of drinking water contamination near an industrial plant was conducted. During this sampling PCBs, trichloroethylene, and other related solvents, as well as chemicals not associated with the industrial plant were detected. This resulted in another sampling program which showed drinking water wells and springs contaminated with the herbicides strazine and alachlor; the highest levels were 260 micrograms/liter and 660 micrograms/liter, respectively. As a result of the groundwater contamination study, homes with private wells polluted with PCBs and/or solvents were hooked up to public water supplies at the expense of the offending industrial plant and alternative water sources were substituted for wells contaminated with pesticides. In Suffolk County following the removal of aldicarb from the Long Island market, oxamyl was used as an alternative pesticide under an experimental use permit. After several years of use, monitoring indicated increasing levels of oxamyl contamination in groundwater, and by January 1984, oxamyl was removed from the Long Island market. (See also W88-09089) (Wood-PTT)
W88-09117

CONSIDERING PESTICIDE POTENTIAL FOR REACHING GROUND WATER IN THE REGISTRATION OF PESTICIDES,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
S. M. Creeger.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 548-557, 7 tab, 13 ref, append.

Descriptors: *Pesticides, *Groundwater pollution, *Water quality control, *Regulations, Degradation, Metabolism, Pesticide mobility, Path of pollutants, Accumulation, Fate of pollutants,Regulations, Agricultural chemicals, Groundwater, Environmental Protection Agency.

Groundwater was once thought unaffected by chemicals applied on the soil's surface, but current evidence shows the presence of at least 1 of 16 different pesticides in the groundwater of 23 different states. The procedures used by the U.S. Environmental Protection Agency in considering the potential of pesticides to reach groundwater in the pesticide registration process are described. Environmental fate data required for terrestrial use patterns and for aquatic and aquatic impact use patterns include degradation, metabolism, mobility, field dissipation and accumulation. The studies used in determining a pesticide's potential to reach groundwater are pesticide hydrolysis, photolysis in water and on soil, aerobic and anaerobic soil metabolism, anaerobic aquatic metabolism, leaching and field dissipation. They are used for new chemical registration, reregistration and amendments to an existing registration. The Ground Water Data Call In initiated by the Agency in 1984 for the purpose of determining which of the 600 most widely used active ingredients have potential to reach groundwater when applied under normal agricultural conditions was described although results were not presented. (See also W88-09089) (Wood-PTT)
W88-09119

ENVIRONMENTAL SAMPLING FOR HAZARDOUS WASTES.
For primary bibliographic entry see Field 7B.
W88-09120

ASSESSING CYANIDE CONTAMINATION FROM AN ALUMINUM SMELTER,
Washington State Dept. of Ecology, Olympia.
For primary bibliographic entry see Field 7A.
W88-09123

NEW WAYS OF ASSESSING SPATIAL DISTRIBUTIONS OF POLLUTANTS,
Stanford Univ., CA. Aerosol Lab.
For primary bibliographic entry see Field 7A.
W88-09127

EVALUATION OF GROUND-WATER CONTAMINATION ASSOCIATED WITH THE USE OF ORGANIC SOLVENTS AT ROMANSVILLE, PENNSYLVANIA,
For primary bibliographic entry see Field 7A.
W88-09138

TRICHLOROETHYLENE OCCURRENCE AND GROUND-WATER RESTORATION IN HIGHLY ANISOTROPIC BEDROCK: A CASE STUDY,
SMC Martin, Inc., Valley Forge, PA.
D. L. Kraus, and A. L. Dunn.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 76-81, 8 fig, 2 ref.

Descriptors: *Water pollution treatment, *Groundwater movement, *Path of pollutants, *Trichloroethylene, *Groundwater pollution, *Chemical pollution, *Cleanup operations, Assessments, Soil contamination, On-site data collections, Air stripping, Aquifer characteristics, Waste recovery, Fracture permeability, Organic solvents, Monitoring, Pennsylvania.

Trichloroethylene (TCE), an industrial solvent, has become a common ground-water contaminant in heavily industrialized areas of eastern Pennsylvania and New Jersey. Numerous TCE losses have occurred as a result of storage tank deterioration and inadequate handling practices. This paper describes the site investigation and ground-water restoration program undertaken by SMC Martin at a steel tubing manufacturing plant in Montgomery County, Pennsylvania, for the cleanup of soil and ground-water contamination with TCE. As a result of soil investigation at this site, the principal source of TCE at the surface was identified and removed. A ground-water recovery system was instituted and treatment of the recovered ground water with a counter-current air stripper had resulted in 99.8 percent removal of TCE, with surface discharges from the plant averaging only 6.5 ppb of TCE. Water-level and water-quality data collecting during a 10-month monitoring period enabled a better definition of the ground-water flow system. It is concluded that the shallow bedrock aquifer beneath the site is characterized by strong anisotropy and/or a north-south trending zone of high permeability related to fracturing. As a result, TCE-contaminated ground water has moved northward toward discharge zones in the marsh and creek off-site. (See also W88-09129) (Friedmann-PTT)
W88-09139

DETECTION, CORRECTION AND RESTORATION OF MINING SOLUTIONS IN A CONFINED AQUIFER AT AN IN SITU URANIUM MINE,
For primary bibliographic entry see Field 5G.
W88-09147

VOLATILIZATION OF ORGANIC COMPOUNDS FROM UNCONFINED AQUIFERS,
Massachusetts Inst. of Tech., Cambridge. Water Resources and Environmental Engineering Div.
J. A. Swallow, and P. M. Gschwend.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 327-333, 6 fig, 2 tab, 32 ref.

Descriptors: *Unconfined aquifers, *Organic compounds, *Volatility, *Mathematical models, *Path of pollutants, *Groundwater pollution, Aquifer management, Biodegradation, Predictions, Air-earth interfaces, Saturation zone, Groundwater recharge, Ficks Law, Henrys Law, Benzene, Toluene, Trichloroethylene.

Sources hazardous volatile organic compounds (VOCs) include septic tank cleaners, landfill leachates, and spills. Once an aquifer is contaminated with VOCs, there are only three natural mechanisms that may eliminate these organic pollutants from the water: microbial biodegradation, chemical transformation and possibly volatilization. The authors have formulated a simple three-box model for the purpose of predicting the importance of volatilization under various circumstances. The model, based on Fick's Law and Henry's Law, was developed to make predictions about vertical transport of volatile organic compounds from shallow aquifers. Volatilization in the laboratory studies was limited by transport through the saturated zone, but nonetheless was relatively fast. Some preliminary field data were represented showing elevated concentrations (relative to the atmosphere) of benzene, toluene and trichloroethylene in the soil air above an aquifer receiving recharge from a sewage rapid infiltration site. This result is consistent with volatilization of these organic contaminants from the water to the atmosphere. A great deal more work must be done (particularly delineating the vertical distribution of VOC in a continuous unsaturated-to-saturated profile) before the importance of volatilization is fully known. (See also W88-09129) (Friedmann-PTT)
W88-09168

ADSORPTION AND MOVEMENT OF ORGANIC POLLUTANTS,
Oklahoma State Univ., Stillwater. Dept. of Geology.
A. W. Hounslow.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 334-346, 12 fig, 1 tab, 36 ref.

Descriptors: *Path of Pollutants, *Adsorption, *Mathematical equations, *Organic compounds, *Adsorption, *Solute transport, *Prediction, Mass transfer, Advection, Biodegradation, Solvents, Solubility, Soil physical properties, Isotherms.

This paper describes adsorption, outlines the methods used to quantify it and to shows how it is incorporated in the mass transport equations used to describe and/or predict pollution movement. The primary purpose of the mass transport equation is to determine the concentration of a pollutant at a specified place after a specified time. The four process incorporated into this equation are advection, disperison, biodegradation, and adsorption. Adsorption is generally considered to be the result of two processes, a lack of affinity of the solute for the solvent or an affinity of the solute for the solid. The first explains the inverse relationship between adsorption and solubility; the second includes the various types of surface phenomena such as physical adsorption, chemisorption and exchange adsorption. The shapes of adsorption isotherms may give some insight as to the nature and possibly the mechanics of the adsorption interactions. One of the more confusing issues that may confront an investigator trying to obtain an approximation to an adsorption coefficient is the diversity of units used in the various equations. (See also W88-09129) (Friedmann-PTT)
W88-09169

MONITORING AND MATHEMATICAL MODELING OF CONTAMINATED GROUNDWATER PLUMES IN PALEOFLUVIAL ENVIRONMENTS FOR REGULATORY PURPOSES,
For primary bibliographic entry see Field 7A.

W88-09171

PRACTICAL GEOHYDROLOGICAL ASPECTS OF GROUND-WATER CONTAMINATION,
W. D. Shepherd.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 365-372, 5 fig, 1 tab, 23 ref.

Descriptors: *Oil spills, *Solute transport, *Geohydrology, *Cleanup, *Groundwater pollution, *Path of pollutants, Aquifer management, Saturation zone, Capillary flow, Plumes, Waste recovery.

This paper attempts to deal with some important facets of underground contamination resulting from spills of petroleum products for those concerned with transport of such contaminants. Misconceptions are dealt with to clarify differences between textbook concepts and field performance and requirements. Principles of contaminant movement are reviewed in the unsaturated and saturated zones. Concepts of phase-separated product, capillary forces and lateral spreading of product are the aspects of contaminant plumes reviewed. Also discussed are soluble plumes, loss and recovery volumetrics, products recovery measures and other mitigative measures. The review is not intended to educate technical experts, but to afford a better understanding of the varied geohydrological aspects of underground contamination for personnel newly involved in cleanup and environmental efforts related to land spills. (See also W88-09129) (Friedmann-PTT)
W88-09172

DIRECT MEASUREMENT OF GASOLINE FLOW,
K-V Associates, Inc., Falmouth, MA.
For primary bibliographic entry see Field 7B.
W88-09175

BIODEGRADATION POTENTIAL OF GROUND-WATER BACTERIA,
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
For primary bibliographic entry see Field 2F.
W88-09176

HYDROGEOLOGIC INVESTIGATIONS OF FAILURE MECHANISMS AND MIGRATION OF ORGANIC CHEMICALS AT WILSONVILLE, ILLINOIS,
For primary bibliographic entry see Field 5E.
W88-09177

OIL SPILL CHEMICAL DISPERSANTS: RESEARCH, EXPERIENCE, AND RECOMMENDATIONS.
American Society for Testing Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5G.
W88-09183

RECOMMENDED METHODS FOR TESTING THE FATE AND EFFECTS OF DISPERSED OIL IN MARINE SEDIMENTS,
Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.
For primary bibliographic entry see Field 7B.
W88-09199

COMPARISON OF THE FATE AND ECOLOGICAL EFFECTS OF DISPERSED AND NONDISPERSED OIL IN A VARIETY OF INTERTIDAL HABITATS,
Field Studies Council, Pembroke (Wales). Oil Pollution Research Unit.
J. M. Baker, J. H. Crothers, D. I. Little, J. H. Oldham, and C. M. Wilson.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, FL, Oct. 12-13, 1982. ASTM, Philadelphia, PA. 1984. p239-279, 14 fig, 7 tab, 17 ref.

Descriptors: *Fate of pollutants, *Oil, *Water pollution effects, *Intertidal areas, *Ecological effects, Dispersants, Oil pollution, Oil spills, Salt marshes, Sea grasses.

Field experiments were carried out to compare the littoral fate and ecological effects of chemically dispersed oil and nondispersed oil. The basic experimental design was a series of treatments applied to marked plots on rocky shores, a salt marsh, an intertidal sea-grass bed, and sand and mud flats. The treatments included a variety of oils and the dispersants BP 1100 WD, BP 1100X, Corexit 8667, and Corexit 7664, applied directly to the intertidal plots. Results from treatments on intertidal rock suggested that oil deposition or oil deposition followed by dispersant cleaning had a greater effect than dispersant cleaning alone on limpets and small winkles. On the salt marsh, oil or oil followed by dispersant cleaning significantly reduced the density of the perennial grass Spartina anglica C.E. Hubbard and the annual plant Salicornia spp. Dispersant alone had relatively little effect on the vegetation. On the sea-grass bed, although variability was high, all treatments reduced the percentage cover of the sea-grass Zostera noltii Hornem. Sediment hydrocarbon analysis indicated little long-term retention of applied oil (whether dispersant treated or not) in the salt marsh mud and in muddy sand on a waterlogged intertidal flat. However, in the sea-grass bed sediments and in the fine sands on freely draining intertidal flats, dispersant-treated oil was, in some cases, retained at greater concentrations than untreated oil. (See also W88-09183) (Author's abstract)
W88-09200

TIDAL AREA DISPERSANT PROJECT: FATE OF DISPERSED AND UNDISPERSED OIL IN TWO NEARSHORE TEST SPILLS,
Bowdoin Coll., Brunswick, ME. Hydrocarbon Research Center.
D. S. Page, J. C. Foster, J. R. Hotham, D. Vallas, and E. S. Gilfillan.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 280-298, 9 fig, 2 tab, 14 ref.

Descriptors: *Tidal waters, *Dispersants, *Fate of pollutants, *Oil spills, *Maine, Field tests, Littoral zone, Oil pollution, Oil, Mixing, Mollusks, Hydrocarbons, Intertidal areas, Sediments.

In 1981, an oil spill field experiment in Maine assessed the effects to the benthos of dispersant used in nearshore oil spills. Three test plots, 60 by 100 m, were set up, each with an upper and a lower intertidal sampling area. There were also five subtidal sampling stations in water depths from 5 to 20 m. One plot served as an untreated reference plot. One plot was exposed to 945 L (250 gal) of Murban crude oil released on an ebbing tide within containment booms and cleaned up by conventional mechanical methods 24 h later. The third plot was exposed to 945 L of Murban crude oil premixed with 94 L (25 gal) of a widely available self-mix nonionic dispersant. The dispersant-treated oil was discharged over a 2-h period around high water slack tide. During discharge, mixing gates augmented natural energy to provide a worst-case scenario for exposure of the benthos to the complete dispersal of a nearshore oil spill. During and after discharge, dispersed oil in water was monitored fluorimetrically. Total integrated exposure of dispersed oil to the bottom at both upper and lower sampling areas was 30 to 40 ppm/h. Discrete water samples were also taken for other analyses. Dispersed oil in water reaching the bottom had lost most of the hydrocarbons more volatile than n-C17 compared with dispersed oil in water sampled at the same time near the surface. Petroleum retention by intertidal sediments and bivalves measured one week after the spill was less in areas exposed to dispersed oil than in areas exposed to untreated oil. (Author's abstract)
W88-09201

EFFECTS OF TEST SPILLS OF CHEMICALLY DISPERSED AND NONDISPERSED OIL ON THE ACTIVITY OF ASPARTATE AMINOTRANSFERASE AND GLUCOSE-6-PHOSPHATE DEHYDROGENASE IN TWO INTERTIDAL BIVALVES, MYA ARENARIA AND MYTILUS EDULIS,
Bowdoin Coll., Brunswick, ME. Marine Research Lab.
For primary bibliographic entry see Field 5C.
W88-09202

COMPARATIVE FATE OF CHEMICALLY DISPERSED AND UNTREATED OILS IN AN ARCTIC NEARSHORE ENVIRONMENT,
Battelle New England Marine Research Lab., Duxbury, MA.
P. D. Boehm.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 338-360, 8 fig, 1 tab, 15 ref.

Descriptors: *Fate of pollutants, *Dispersants, *Oil pollution, *Arctic zone, *Littoral zone, *Cape Hatt, *Baffin Island, Intertidal areas, Chemical treatment, Hydrocarbons, Oil spills, Chemical analysis, Comparison studies, Benthic environment, Water pollution treatment.

The distribution and environmental fate of petroleum hydrocarbons introduced into the nearshore environment of Cape Hatt, Baffin Island, Canada, during two controlled experimental discharges of a Venezuelan (Lagomedio) crude oil were studied. An analytical program based on a combination of ultraviolet/fluorescence studies, high resolution gas chromatography, and computer-assisted gas chromatographic mass spectrometry was used to examine several hundred oil, seawater, sediment, sediment trap, surface floc, and benthic animal (seven species) samples to determine the distribution, transport, and weathering of oil spilled in two scenarios: as untreated oil on the surface and as chemically dispersed oil discharged below the surface. Conclusions are drawn about the weathering of oil in the two scenarios, transport of low and high molecular weight hydrocarbons into the water column and their persistence, the sedimentation of oil, the incorporation of oil into the sediment via sedimentation on to the surface floc and direct penetration of the sediment/water interface, and the uptake and depuration of untreated and chemically dispersed oils by seven species of filter feeders and deposit feeders in the subtidal benthos. During the first 2-3 wk after the spills, there was a noticeable lack of significant biodegradation of oil in the water column and in the sediments in either spill scenario. There was no chemical evidence for the existence of biodegradation as a removal mechanism within the short-term period (3-wk) after the spill. Degradation of petroleum n-alkanes resulting in the loss of n-alkanes relative to isoprenoid and other highly branched alkanes was observed in all animal species. Rapid degradation of alkanes apparently only occurs in vivo. For reasons not yet understood, the animals in the study area did not acquire oil at levels directly related to the water column levels, possibly because the animals slowed or ceased pumping water because of the high levels of oil in the water. (See also W88-09183) (Author's abstract)
W88-09205

MATHEMATICAL MODEL FOR PREDICTING THE ECOLOGICAL IMPACT OF TREATED AND UNTREATED OIL SPILLS,
Ross (S.L.) Environmenal Research Ltd., Ottawa (Ontario).
For primary bibliographic entry see Field 5C.
W88-09208

METAL AND RADIONUCLIDE CONCENTRATIONS IN L-LAKE SEDIMENTS,
D. C. Adriano, W. G. Burkman, J. W. Bowling, and C. L. Strojan.

IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 7-11, 1 fig, 2 tab.

Descriptors: *Radioisotopes, *Metals, *Radionuclides, *Lake sediments, *Path of pollutants, Iron, Manganese, Cycling, Mixing, Steel Creek, Sediment contamination, Organic matter, Cesium radioisotopes, Litter, South Carolina.

The cycling of iron, manganese and other metals can have important ecological implications in acidic southeastern lakes and reservoirs. When water in a lake's hypolimnion is anoxic, as typically occurs in summer, the solubility of certain elements, such as iron and manganese, increases. During such anoxic conditions, remobilization of elements from lake sediments into the hypolimnion may also occur. Concentrations of these elements can reach levels that are toxic to organisms. Perhaps more importantly, when turnover of the water column occurs in autumn, oxygenation of the anoxic hypolimnion may cause precipitation of metal oxides, forming colloids that can be harmful to fish and other organisms. Soil cores were collected from 150 surveyed sites in L-lake basin in August 1985, just prior to lake filling. Samples were collected randomly along 14 transects that were perpendicular to Steel Creek at approximately 300-m intervals. The lower portion of the basin was not sampled because of construction activities in the vicinity of the dam. Fifty of the sites were in areas of the Steel Creek floodplain thought to be contaminated with low levels of radionuclides from earlier reactor operations. The ranges of element concentrations in surface and subsurface soils were similar. On average, concentrations in surface soils were higher than those in subsurface soils. Average element concentrations at the 50 sites in the Steel Creek floodplain were higher than those found at the 100 upland sites. This is not unusual and reflects: (1) the naturally higher concentration of elements found in floodplain soils that are higher in organic matter and clay mineral content compared with upland soils; (2) the impact of clearing vegetation and soil litter from upland portions of the L-Lake basin, so that upland soils that were analyzed were essentially bare mineral soil; and (3) effects from prior reactor operations that resulted in higher 137-Cs concentrations than could be attributed to global atmospheric fallout. None of the element concentrations can be considered abnormally high. The differences between upland and floodplain soils result primarily from the very low element concentrations found in the upland soils, not from unusually high levels in the floodplain samples. (See also W88-09211) (Lantz-PTT)
W88-09212

UTILIZATION OF SELECTIVE DISSOLUTION METHODS FOR ASSESSING 137-CS MOBILITY AND BIOAVAILABILITY,

For primary bibliographic entry see Field 7B.
W88-09213

INVENTORIES OF 137-CS, 90-SR AND 239,240-PU IN POND B: IMPLICATIONS FOR THE RELATIVE IMPORTANCES OF RADIONUCLIDE CYCLING PROCESSES IN LAKE ECOSYSTEMS,

F. W. Whicker, J. W. Bowling, M. S. Kelly, J. E. Pinder, and K. A. Orlandini.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 17-22, 4 fig.

Descriptors: *Path of pollutants, *Cesium radioisotopes, *Strontium radioisotopes, *Plutonium radioisotopes, *Cooling ponds, *Lake morphology, *Ecosystems, Radionuclides, Bioaccumulation, Plants, Macrophytes, Water column, Chemical analysis, Biological studies, Surveys, Savannah River Plant, South Carolina, Nuclear industry.

Although radionuclide cycling studies have been performed in Pond B, Par Pond and other lake and pond habitats on the Savannah River Plant, there have been few studies designed to estimate total radionuclide inventories or the inventories in various components of these ecosystems. Because inventory data were lacking for SRP lakes and for southeastern lakes in general, a study was initiated in 1983 to inventory the 90-Sr, 137-Cs and 239,240-Pu contents of Pond B sediments and biota. The radionuclide inventories in the sediments were determined from randomly located sediment cores taken from throughout the pond. Samples were also collected at various times of the year to estimate the radionuclide contents of the water column. The appropriate samples were also collected to estimate the biomass and radionuclide inventories in the major biological components of the pond. Data were obtained on macrobenthic organisms and various vertebrate species, but the greatest emphasis was placed on estimating the biomass and radionuclide contents of the aquatic macrophytes. As would be expected from the greater solubility of Sr relative to Cs, a greater fraction of the total 90-Sr inventory is present in the water column. Approximately 10% of the 90-Sr inventory is in the water column, whereas < 1% of the 137-Cs inventory is present in the water. For both 90-Sr and 137-Cs, a significant fraction of the total inventory is contained in the macrophytes. The 137-Cs inventories in the water column and the macrophytes are similar, which raises questions concerning the role of macrophytes in modifying the annual cycle of 137-Cs contents in the water. The inventories of 137-Cs in the water columns of Pond B and Par Pond demonstrate pronounced seasonal cycles with a minimum content in the spring and a maximum content in the fall. Less than 0.1% of the total inventory of 239,240-Pu is present in the water column. Moreover, the ratios of 238-Pu to 239,240-Pu in the water and the macrophytes suggest that atmospheric deposition is making significant contributions to the Pu contents of these components. (See also W88-09211) (Lantz-PTT)
W88-09214

SETTLING RATES OF PLUTONIUM-BEARING PARTICLES IN POND B,

Argonne National Lab., IL.
K. A. Orlandini, J. W. Bowling, and J. E. Pinder.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 23-27, 2 fig, 1 tab.

Descriptors: *Particulate matter, *Cooling ponds, *Settling velocity, *Plutonium radioisotopes, *Sedimentation, *Path of pollutants, Water column, Mixing, Cycling, Seasonal variation, Savannah River Plant, South Carolina, Yttrium radioisotopes, Equilibrium, Chemical analysis.

Previous research has demonstrated an annual cycle in the 239,240-Pu inventories in the water column of Pond B. Research is currently being conducted in Pond B to determine the relative importance of: (1) changes in particle settling rates; (2) changes in remobilization rates; and (3) the influence of the macrophytes on the annual cycle in 239,240-Pu inventories. The initial research has emphasized: (1) an evaluation of the importance of particle adherence to macrophytes in reducing Pu inventories in the water column and (2) measurements of particle settling rates at different times of the year. Particle settling rates are being measured using the disequilibrium between 90-Sr and its daughter isotope 90-Y in the water column. Strontium-90 has a half-life of 28 years. Yttrium-90 has a half-life of 64 hours. The soluble 90-Sr decays to insoluble 90-Y which adsorbs to particles in the water column. If there is no settling of particles, then the 90-Sr and 90-Y contents of the water should be equal and in equilibrium. The Sr and Y data suggest an average particle loss rate of approximately 0.02/d with the rate possibly being greater in March than in June. Loss rates of 0.02/d indicate a residence half-time for particles of approximately 35 days in the upper 3 m of the pond. The suggested faster settling rate in March is opposite to that required to produce the observed 239,240-Pu contents of surface waters. Particle loss rates of approximately 0.02/d are consistent with the rates of decline of 239,240-Pu inventories from March through September. (See also W88-09211) (Lantz-PTT)
W88-09215

ENVIRONMENTAL CHEMISTRY OF SODIUM TETRAPHENYLBORON: PHOTOCHEMICAL DEGRADATION,

G. L. Mills, and D. J. Carter.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 28-33, 4 fig, 3 tab.

Descriptors: *Path of pollutants, *Fate of pollutants, *Chemical analysis, *Degradation, *Photochemistry, *Sodium tetraphenylboron, Diphenylborinic acid, Photolysis, Chemical reactions, Organic matter.

Several studies investigating the fate and effects of sodium tetraphenylboron (NaTPB) in the environment are currently in progress. This report summarizes the results of the studies on photochemical degradation. Previous studies have shown that one of the major products of degradation of NaTPB in the soil environment is diphenylborinic acid (DPBA). Thus, investigations have been expanded to include the chemical behavior, fate and effects of DPBA. Photochemical reactions may be classified into two major categories, direct photolysis and indirect or sensitized photolysis. In direct photolysis the molecule (M) absorbs light and becomes electronically excited (M*). The excited molecule then either loses energy and decays back to ground state or undergoes a chemical reaction to form new compounds. Sensitized photolysis occurs when a molecule (S) absorbs light, becomes electronically excited (S*) then transfers this energy or reacts with another acceptor molecule (A). The excited acceptor (A*) subsequently reacts to form products. These studies indicate that the rates of direct photolysis of tetraphenylboron and DPBA in sunlight are slow but are significantly increased by natural photosensitizers in stream water. Dissolved organic matter was an important sensitizer; however, other components may also play a role. The rate of sensitized degradation decreased with increasing pH and with increasing dissolved O2 concentration. (See also W88-09211) (Lantz-PTT)
W88-09216

POLYCYCLIC AROMATIC HYDROCARBONS IN SRP AQUATIC SEDIMENTS,

G. L. Mills, and D. Norton.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report No. SRO--819-17, (1986). p 34-37, 2 fig, 1 tab.

Descriptors: *Path of pollutants, *Coal wastes, *Aromatic compounds, *Sediments, *Hydrocarbons, *Savannah River, *Aquatic soils, Coal mines, Organic compounds, Mine wastes, Benzo-a-pyrene, South Carolina, Savannah River Plant.

Although numerous studies have addressed the problem of inorganic contaminants associated with runoff from coal piles, little information is available on contamination by organic compounds, including polycyclic aromatic hydrocarbons (PAH), that are known to be present in coal. During the past year, the Savannah River Laboratory began a study to determine the input of PAH from coal pile runoff in the 400 D-Area to the aquatic systems on the Savannah River Plant (SRP) and the Savannah River. Sediment samples from 17 locations in various streams on the SRP have been collected and analyzed. In addition, sediments from 10 locations in the Savannah River, including sites above and below the lock at the city of Augusta, as well as locations above, adjacent to and below the SRP, have been collected. Several of the priority pollutant PAH were found in all of the samples analyzed from the SRP streams. Benzo-a-pyrene (BaP) was present in the highest concentrations, ranging from 8.3 to 170.2 ng/g (ppb). The biological activity of BaP has been studied extensively; it is both mutagenic and carcinogenic. Although several PAH are present in the sediments of the coal pile retention basin (CRCP), the higher molecular weight 5- and 6-ringed compounds, including BaP, were not detected. Conversely, BaP was the only PAH detected in the sediment sample taken from the 400 D-Area fly ash basin. Although runoff from coal piles and effluents from the fly ash basin may contribute PAH

to the SRP streams and swamp, the complex assemblage of PAH compounds and their widespread distribution suggest multiple sources. Certainly other inputs are required to account for the higher molecular weight compounds such as benzofluoranthene, indenopyrene, dibenzanthracene and benzolperylene. Future studies will help identify other sources, as well as provide additional information on the relative contribution from coal pile runoff and effluents from fly ash basins. (See also W88-09211) (Lantz-PTT)
W88-09217

CHEMICAL SPECIATION AND TRANSPORT OF HEAVY METALS IN SRP AQUATIC SYSTEMS,
P. M. Bertsch, C. Loehle, M. A. Anderson, and M. A. Elrashidi.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 38-42, 3 fig.

Descriptors: *Chemical speciation, *Transport, *Aquatic environment, *Path of pollutants, *Fate of pollutants, *Heavy metals, MEXAMS, Metal exposure analysis modeling system, Cadmium, Copper, Sediment contamination, Flow profiles, Water column, Water temperature, Nuclear reactors, Savannah River Plant, South Carolina.

Total metal concentrations in the water column provide little predictive information concerning possible detrimental impacts on the environment, although current regulations for effluent discharge are based on these criteria. Rather, for many metals the chemical form of the dissolved constituent determines its relative toxicity. In addition, the partitioning of metals between solid and dissolved phases via adsorption and desorption processes also depends on metal speciation, and it is this partitioning that largely controls transport. In an attempt to provide predictive capabilities and better understand the transport of heavy metals and radionuclides in Savannah River Plant (SRP) aquatic systems, the chemical speciation-transport model MEXAMS (Metal Exposure Analysis Modeling System) has been implemented and is being tailored for site-specific application to SRP aquatic systems. Speciation simulations of Pb, Cd, Ni, Zn, and Cu in various SRP streams indicated that thermal discharges associated with SRP cooling water operations influence the distribution of metal complexes. Transport of Cu and Cd in Pen Branch as influenced by K-Reactor operation was simulated. The steady state resident mass values for the reactor up and down conditions reveal that the sediments accumulated much greater amounts of Cu during reactor operation compared with cold flow conditions, due to the much greater total amounts of Cu entering the system because of the increased flow. The Cd transport profiles of the system during reactor operation and during cold flow were also analyzed. The sediments accumulated greater amounts of Cd during reactor operation than during cold flow, although these differences were small compared with those observed for Cu transport. The steady state Cd concentrations in the water column were greater for the reactor down condition, in contrast to Cu. The simulations conducted exemplify the importance of organic-metal complexation constants, solid phase formation kinetics, oxidation-reduction reactions, and more specifically defined Kd values for metals with suspended and benthic sediments in predicting metal speciation, which in turn influences transport. (See also W88-09211) (Lantz-PTT)
W88-09218

POTENTIAL CATION LEACHING LOSSES FOLLOWING DISTURBANCE ACROSS A SOUTHEASTERN COASTAL PLAIN LANDSCAPE GRADIENT,
For primary bibliographic entry see Field 4C.
W88-09222

SIZE-DEPENDENT PHARMACOKINETICS OF TRACE ELEMENT ACCUMULATION BY GAMBUSIA AFFINIS WITH EMPHASIS ON ZINC,
M. C. Newman, and S. V. Mitz.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 78-82, 4 fig, 1 tab.

Descriptors: *Fish, *Gambusia, *Pharmacokinetics, *Trace elements, *Zinc, *Fate of pollutants, *Bioaccumulation, Metabolism, Biological studies, Mathematical studies, Tissue analysis.

Most size-dependent relationships for contaminant body burdens fit into one of two classes displaying b-values (exponents) of either one or less than one. Previous studies suggested that for the relationship where b=1, the body burden was determined by the amount of tissue available to bind a trace element, and the relationships with b-values of < 1 (averaging 0.77) implied a connection with metabolism, 'as many metabolic processes display a similar relation to body weight'. However, this linkage has never been established between size-dependent body burdens of contaminants and size-dependent metabolic rate. It further suggested that the b-value for a particular species/trace element combination was a constant. The purpose of the present study was to develop an animal model to test the following hypotheses: (1) Linking to size-dependent metabolic rate can be implied for relationships with b-values of < 1 as the b-value is the same as the b-value for the size-dependent metabolic rate relationship, and (2) if the implied linkage between size-dependent metabolic rate and size-dependent body burden is not correct then a simple pharmacokinetic model can produce a size-dependent body burden relationship with a b-value of < 1. (See also W88-09211) (Lantz-PTT)
W88-09225

DISPERSION OF RADIOACTIVELY CONTAMINATED TURTLES ON THE SRP: RESEARCH AND RECONNAISSANCE,
T. Lamb, B. Taylor, and J. W. Gibbons.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 115-120, 1 fig, 2 tab.

Descriptors: *Path of pollutants, *Radioactivity, *Turtles, *Savannah River Plant, Genetics, Habitats, Model studies, Migration, Ecology, Surveys, Nuclear industry.

Turtles contaminated with radionuclides have been reported from a number of sites on the Savannah River Plant (SRP), and movement to and from contaminated habitats is now well documented. The problem of radionuclide contamination in turtles and their dispersal through aquatic sites on and off the SRP was approached along three fronts, in this study. The first involved site reconnaissance, where aquatic habitats adjacent to contaminated areas on the SRP were identified and surveyed for contaminated turtles. The second approach involved the development of a dispersal model. Third, mitochondrial DNA analysis was conducted to assess genetic differentiation between turtle populations inhabiting either side of the Savannah River near SRP. (See also W88-09211) (Lantz-PTT)
W88-09231

MANAGEMENT OF GROUND WATER QUALITY BENEATH IRRIGATED ARID LANDS,
Schmidt (Kenneth D.), Fresno, CA.
For primary bibliographic entry see Field 4B.
W88-09250

DEVELOPMENT OF A PLAN TO PROTECT LOS ANGELES' SAN FERNANDO VALLEY GROUND WATER BASIN FROM INDUSTRIAL CONTAMINATION,
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 5G.
W88-09267

CLATSOP PLAINS, OREGON: DUNAL AQUIFER EVALUATION AND GROUND WATER PROTECTION PLAN,
Sweet, Edwards and Associates, Inc., Kelso, WA.
For primary bibliographic entry see Field 5G.
W88-09268

USE OF WELL PACKERS TO CONTROL TCE AND PCE CONTAMINANTS,
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 5G.
W88-09278

ARE HUMID AREA MONITORING CONCEPTS APPLICABLE TO ARID LANDS,
Schmidt (Kenneth D.), Fresno, CA.
For primary bibliographic entry see Field 7A.
W88-09287

DESIGN OF A MONITORING NETWORK TO DETECT THE EFFECTS OF LAND USE ON GROUND WATER QUALITY AND DESCRIBE THE CONTAMINANT FLOW SYSTEM IN THE PIEDMONT OF NORTH CAROLINA,
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7A.
W88-09293

USE OF PRESSURE DIFFERENTIAL MEASUREMENTS TO MAP CHEMICAL-QUALITY VARIATIONS IN A VARIABLE-DENSITY GROUND WATER SYSTEM,
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 7A.
W88-09294

APPLYING THREE DIMENSIONAL GROUND WATER MODELING TO MONITORING NETWORK DESIGN: A CASE HISTORY,
Camp, Dresser and McKee, Inc., Detroit, MI.
For primary bibliographic entry see Field 7A.
W88-09295

EXPECTING THE UNEXPECTED,
Oklahoma State Univ., Stillwater. Dept. of Geology.
For primary bibliographic entry see Field 7A.
W88-09298

SCREEN LENGTH SELECTION FOR USE IN DETECTION MONITORING WELL NETWORKS,
Giddings (Todd) and Associates, Inc., State College, PA.
For primary bibliographic entry see Field 7A.
W88-09308

APPLICATION OF MICROCOSM TECHNOLOGY TO STUDY THE BIODEGRADATION POTENTIAL OF A SUBSURFACE ALLUVIAL MATERIAL EXPOSED TO SELECTED PETROLEUM HYDROCARBONS,
Engineering Enterprises, Inc., Norman, OK.
B. Mahadeviah, and G. D. Miller.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 384-412. 8 fig, 9 tab, 14 ref.

Descriptors: *Gasoline, *Microorganisms, *Microbiological studies, *Biodegradation, *Self-purification, *Groundwater pollution, *Organic compounds, *Hydrocarbons, *Fate of pollutants, *Aromatic compounds, Detection limits, Limiting nutrients, Prediction, Metabolites, Aquifers, Groundwater, Wastewater treatment, Benzene, Xylene, Toluene.

Natural biodegradation may be an important process that mitigates against the spread of petroleum hydrocarbons in the subsurface. This study evaluated the biodegradation potential of a subsurface material aseptically obtained from alluvial deposits of the South Canadian River basin, in central Oklahoma, exposed to benzene, toluene, ethylbenzene, and para, meta and otho-Xylene, using batch aerobic microcosm techniques. All of the tested hydrocarbons were rapidly degraded in the non-autoclaved alluvial material to below detection limits. However, the hydrocarbons in the autoclaved ma-

terial also disappeared but at a slower rate by chemical and physical processes. This nonbiological loss of hydrocarbons was most likely due to volatilization, diffusion, and adsorption. Higher rates of decreases in the concentrations of the petroleum hydrocarbons in the non-autoclaved material compared to those in the autoclaved material indicated the presence of microorganisms and their ability to biodegrade the test contaminants. Attempts to enhance biodegradation by the addition of various nutrient compounds were unsuccessful. Further research in this area is necessary to optimize a nutrient dose that can enhance the metabolic activity and to determine the limits to this laboratory approach as a tool to predict what will occur in the field. (See also W88-09283) (Author's abstract)
W88-09315

RECOVERY OF PETROLEUM PRODUCT FROM A HIGHLY PERMEABLE AQUIFER UNDER THE EFFECTS OF MUNICIPAL WATER SUPPLY WELLS,
IT Corp., Pittsburgh, PA.
For primary bibliographic entry see Field 2F.
W88-09322

APPLICATION OF A GROUND-WATER-QUALITY MANAGEMENT MODEL TO THE EQUUS BEDS AQUIFER IN KANSAS,
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 5G.
W88-09331

CHARACTERIZATION OF GROUND WATER CONTAMINATION ASSOCIATED WITH COAL MINES IN WEST VIRGINIA,
Camp, Dresser and McKee, Inc., Denver, CO.
G. N. McCurry, and H. W. Rauch.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 669-685. 5 fig, 20 ref.

Descriptors: *Path of pollutants, *Acid mine drainage, *Sulfates, *Coal mining, *Acidic water, *Groundwater monitoring, *Groundwater pollution, *Monitoring wells, Analytical methods, Sampling devices, Measuring instruments, Surface-groundwater relations, Groundwater management, Chemical analysis, Geohydrology, Hydrology, Spatial distribution, Temporal distribution, Hydraulic conductivity, Permeability coefficient, Aquifers, Groundwater, Well waters, Spring water, Iron, Manganese, Hydrogen ion concentration, West Virginia.

One hundred thirty-four domestic water wells and springs located near coal mines in Preston County, West Virginia, were sampled to determine the impacts of acid mine drainage on the groundwater regime. Analyses of the primary chemical constituents associated with coal mine drainage (pH, iron, manganese and sulfate) revealed that sulfate concentration is the most reliable parameter for evaluating mining impacts. Samples sites located upgradient of mines indicate that background sulfate concentrations are less than 50 mg/L. Monitoring water wells and springs located in varying hydrogeologic settings with respect to surface and underground mines made it possible to characterize the horizontal, vertical, and temporal extent of mine drainage contamination. Shallow groundwater flow systems are affected by mine drainage much more severely than are deeper groundwater flow systems, and the hydraulic gradient from a coal mine to a well or spring has a strong effect on the severity of contamination. Surface coal mines were found to produce higher levels of contamination than underground coal mines of the same seam. Surface mines were also found to contaminate groundwater two to three times farther away laterally from a mine and approximately twice the depth below the coal than do underground mines of the same coal seam. The more extensive nature and higher levels of contamination associated with surface coal mines are probably due to their closer proximity to upland recharge zones, to the higher concentration of stress-relief fractures which increase aquifer hydraulic conductivity, and to increased oxidation of the acid producing minerals present in the coal and adjacent rocks. Groundwater contamination due to coal mining in both surface and underground mine settings appears to be most severe four to six years after mining begins. After this peak, underground coal mines are likely to contaminate groundwater for a greater number of years following mining than are surface mines. (See also W88-09283) (Author's abstract)
W88-09332

CONTAMINANT TRANSPORT MODELING FOR A PROPOSED HAZARDOUS WASTE SITE,
Harza Engineering Co., Chicago, IL.
C. B. Burke, D. I. Leib, J. R. Ghia, and A. J. Frano.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 686-703. 7 fig, 14 ref.

Descriptors: *Unsaturated flow, *Waste disposal, *Plumes, *Landfills, *Model studies, *Groundwater pollution, *Path of pollutants, *Solute transport, Geohydrology, Hydrology, Simulation, Mathematical studies, Finite element method, Soil properties, Aquifers, Groundwater, Porous media, Computer models, Hazardous waste, Groundwater monitoring, Groundwater management.

The paper focuses on describing a computer modeling approach that enabled the authors to efficiently solve a complex three-dimensional transport problem. Many proposed hazardous waste sites are situated above the water table. If leakage should occur, the first basic transport path will be vertically downward toward the water table. After penetrating the saturated zone, the contaminant plume will move in the dominant groundwater flow direction, dispersing in the longitudinal and transverse directions. The vertical transport is more complicated because, in the unsaturated zone, important transport parameters vary with the suction pressure. To accurately simulate complex behavior in this zone, mathematically rigorous two-dimensional (x-z) numerical models can be used. In the saturated zone, important transport parameters are independent of pressure. This greatly simplifies the modeling task. Accurate representation of transport can be achieved with a computationally efficient (and simpler) two-dimensional (x-y) analytical model. The input to this model is to output from the more complex numerical model. Thus the three-dimensional problem has been divided into two linked, two-dimensional problems. The authors demonstrate how the overall objective of one such project was satisfied by this approach using finite element models for the unsaturated zone and an extended pulse approximation for the saturated zone. An essential component of this particular study was the development of the unsaturated soil properties of the porous media. A discussion of the techniques employed in determining these relationships is included. (See also W88-09283) (Alexander-PTT)
W88-09333

TOXIC TERROR,
American Council on Science and Health, New York.
E. M. Whelan.
Jameson Books, Ottawa, Illinois. 1985. 348 p.

Descriptors: *Water pollution effects, *Toxicity, *Water pollution sources, *Pollutant identification, Pesticides, Polychlorinated biphenyls, Dioxins, Formaldehyde, Nuclear powerplants, Acid rain.

One by one, mankind's most useful and safe chemicals have come under assault, and have been banned on the basis of fragmentary or discredited evidence. The result has been the return of malaria and other diseases that were once conquered. The myths and realities of a variety of chemicals and technologies, including pesticides, PCBs and PBBs, dioxin, formaldehyde are examined in this book. The Love Canal 'disaster', nuclear energy, acid rain, air and water pollution, are also discussed at length. (Lantz-PTT)
W88-09359

ENTROPY RACES SUPERFUND,
Office of Technology Assessment, Washington, DC.
For primary bibliographic entry see Field 6E.
W88-09381

STATE INVOLVEMENT IN AN EPA LEAD SUPERFUND REMEDIAL ACTION,
Iowa Dept. of Natural Resources, Des Moines.
For primary bibliographic entry see Field 5G.
W88-09384

TOXICITY OF PESTICIDES TO FISH,
Nagarjuna Univ., Nagarjunanagar (India). Dept. of Zoology.
A. S. Murty.
Volume I. CRC Press, Inc., Boca Raton, Florida. 1986. 178 p.

Descriptors: *Path of pollutants, *Fate of pollutants, *Water pollution effects, *Bioaccumulation, *Fish, *Pesticides, *Toxicity, Lethal limits, Bioassays, Chemical analysis.

The fate of pesticides in the aquatic environment, specifically on the accumulation in fish of toxic levels of pesticides is discussed. Various tests for determining toxicity are given in the final chapter of this volume, which emphasizes the need to distinguish between toxicity tests, which evaluate the adverse effect of a toxicant, and bioassay tests, which measure the concentration or amount of a chemical or effluent, using the known response of a test organism. To ensure reproducibility of the tests, not only should the test fish be of uniform size and unstressed, but the physicochemical and biological conditions of the test should be as uniform and optimal as possible. Flow-through tests ensure such uniform conditions, but static tests, too, are useful in toxicity testing. Prolongation of the short-term test beyond 96 hr seems rarely necessary and seldom justifies the additional expenditure. LC 50, the concentration that kills 50% of the test population in a given period of time, is used as a measure of toxicity in short-term tests. A number of methods are available for calculating this value and test results with one or no partial kills need not be discarded. Writing the LC 50 with a subscript (as LC sub 50) is not historically justified. Methods for assessing the toxicity of aged solutions or to compare the relative toxicity of two or more compounds have been described. The use of a standard test fish and reference toxicants has been recommended for comparing test results of the same laboratory at different times or those of different laboratories, but such a practice is not yet standard and its utility has been questioned. The different types of toxicity tests in vogue and their relative usefulness have been reviewed. (See also W88-09398) (Lantz-PTT)
W88-09397

TOXICITY OF PESTICIDES TO FISH,
Nagarjuna Univ., Nagarjunanagar (India). Dept. of Zoology.
A. S. Murty.
Volume II. CRC Press, Inc., Boca Raton, Florida. 1986. 143 p.

Descriptors: *Path of pollutants, *Fate of pollutants, *Bioaccumulation, *Water pollution effects, *Pesticides, *Fish, *Toxicity, Lethal limits, Bioassays, Biodegradation, Insecticides, Polychlorinated biphenyls, Chemical reactions.

The toxicity of pesticides to fish (both acute and chronic) and the various factors that modify the toxicity are discussed. Joint action of pesticides on fish is poorly understood and the theoretical premises to study this problem are not well defined. Many of the reported changes, however, are not dose-dependent, and often are observed only in laboratory experiments and not in the field. Further, in the case of biochemical changes, results of in vitro studies often differed from those of in vivo studies. In terms of present utility, acute toxicity

tests followed by embryo-larval tests and chronic life cycle tests are ranked highest; histological tests are ranked 9th, and physiological and biochemical tests 10th out of 11 tests. Since the ultimate aim of all toxicity testing is to assess how deleterious a compound will be to the biota, present-day toxicity test protocols lay stress on preventing a disaster, rather than taking corrective action after its occurrence, as was the case with DDT and other organochlorine (OC) compounds in the late 1960s and early 1970s. Present-day aquatic toxicity testing is concerned more with the protection of diverse aquatic organisms, rather than with the enumeration of the lethal and sublethal effects of one toxicant on a single species. This volume discusses this toxicity testing with respect to: the toxicity of formulations, isomers, and degradation products; joint action of pesticide mixtures; insecticide resistance in fish; and polychlorinated biphenyls and related compounds. (See also W88-09397) (Lantz-PTT)
W88-09398

PERMEABILITY AND GROUNDWATER CONTAMINANT TRANSPORT.
American Society for Testing and Materials, Philadelphia, PA.
A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. 251 p. Edited by T. F. Zimmie, and C. O. Riggs.

Descriptors: *Permeability, *Groundwater pollution, *Path of pollutants, *Solute transport, Groundwater movement, Geohydrology, Hydraulic conductivity, Geotechnology.

Many of the engineers and geologists who are now involved in groundwater seepage analyses and evaluation of contaminant transport problems cut their teeth in geotechnical engineering on problems of the stability of embankments and foundations. The guidelines for analysis were established by educators and practitioners who recognized that almost every act performed during exploration, field testing, and laboratory testing contributed to the conservative nature of the solution. The possible magnitude and nature (which can be either conservative or unconservative with respect to the problem at hand) of errors from both laboratory and field measurements of hydraulic conductivity (permeability) is thoroughly discussed by various contributors in this volume. The contributions to this volume in the area of groundwater contaminant transport reflect the tremendous increase in activity in the area of waste disposal, an area in which geotechnical engineers are now heavily involved. Permeability is only one of the many parameters required to predict groundwater contaminant transport. It is evident that there is a pressing need for the development of standards dealing with groundwater contaminant transport as related to waste disposal. (See W88-09435 thru W88-09447) (Lantz-PTT)
W88-09434

GLOSSARY,
Woodward-Clyde Consultants, Denver, CO.
A. I. Johnson.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 3-17, 2 tab, 8 ref.

Descriptors: *Glossary, *Groundwater pollution, *Permeability.

In presenting an interdisciplinary symposium on permeability and groundwater contaminant transport, there is considerable chance for lack of communication between the engineers and scientists of the many different disciplines interested in these subjects. To assist in better communication between the disciplines involved in permeability and capillarity testing of soils and rocks, a glossary and conversion factor tables are provided. Nearly 100 terms are listed alphabetically, followed by brief definitions. The source is indicated for each definition, and the sources are listed in the reference section following the glossary. The two tables of conversion factors also are presented to assist in conversion of the units used by the various disciplines. (See also W88-09434) (Author's abstract)
W88-09435

PERMEABILITY OF SOILS USING CONTAMINATED PERMEANT,
Woodward-Clyde Consultants, San Francisco, CA.
B. B. Gordon, and M. Forrest.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 101-120, 6 fig, 2 tab, 2 ref, append.

Descriptors: *Path of pollutants, *Groundwater movement, *Soil contamination, *Permeability, *Soil water, Solute transport, Porosity, Porous media, Groundwater pollution, Aeration zone, Viscosity, Chemical properties.

Two laboratory permeability testing programs involving the use of contaminated fluids as permeants are described. The first program involves the use of an alkaline permeant, and in the second program, an acidic permeant is used. Contaminated permeants were used in order to model field conditions anticipated in mining projects. Permeability depends on the properties of both the porous media and the permeant, whereas intrinsic permeability depends only on the void space of the porous material. The chemical and physical properties of the permeants were different from those of distilled water, which is normally used as a permeant. Conclusions drawn from the tests include: (1) The permeability of the sedimented muds in the pond system was controlled by the presence of chemicals in the voids of the materials and will fluctuate with changes in temperature and chemical concentration of the pond water; (2) The curve of permeability versus void ratio for the 1% solution represents a result most consistent with standard soil mechanics theory. The similar curve for the 14% solution is strongly affected by chemicals in the voids of the muds; (4) Under chemically unsaturated conditions and at nominal temperatures, the permeability of the muds will be lower in the fluids with a higher concentration of sodium carbonate and vice versa; (5) Tailings effluent does not appear to affect adversely the permeability coefficient of the soil material proposed for use as a pond liner or embankment core, or both; (6) The permeability of soil depends on the properties of both the soil and the permeant; and (7) The viscosity and specific weight of the acidic tailings solution used in this project, although not measured, can be expected to differ from those of water, and, therefore, they would have an effect on the measured permeability coefficient. (See also W88-09434) (Lantz-PTT)
W88-09439

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF PARTIALLY SATURATED SOILS,
Law Engineering Testing Co., Houston, TX.
For primary bibliographic entry see Field 2G.
W88-09444

PREDICTIVE TOOLS FOR CONTAMINANT TRANSPORT IN GROUNDWATER,
Weston (Roy F.), Inc., West Chester, PA.
A. A. Metry.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 197-208, 6 ref.

Descriptors: *Path of pollutants, *Groundwater pollution, *Prediction, *Groundwater movement, Monitoring, Water quality control, Diffusion, Chemical reactions, Biodegradation, Soil water, Model studies, Mathematical models, Computer models, Simulation analysis.

The management and ultimate disposal of residual waste is subject to stringent programs, many of which were established by enactment of the Resource Conservation and Recovery Act of 1976. Federal and state regulations are now requiring operators of waste disposal sites to minimize environmental impact. Among the most critical areas of concern is groundwater quality. Previous practices of waste disposal have resulted in many serious episodes of water resource contamination. The potential for groundwater contamination could have been reduced if disposal facilities had been located on the basis of their geohydrologic suitability. Understanding mass transport mechanisms that influence migration and attenuation of contaminants is a key element in disposal site selection, and design of monitoring and contaminant migration potential are essential in the evaluation of disposal sites and anticipation of groundwater pollution potential. Several attenuation mechanisms play a role in reducing the potential for groundwater contamination: the physical processes include molecular diffusion, hydrodynamic dispersion, and dilution; the chemical processes include precipitation, oxidation-reduction, and ion exchange; and the biological processes include biodegradation. Among the predictive tools discussed in this paper are mathematical and computer simulation, criteria listing and criteria ranking methods, matrix analysis, and decision tree analysis; the report includes an analysis of the advantages, limitations, and applicability of different tools. (See also W88-09434) (Lantz-PTT)
W88-09445

COMPUTER SIMULATION OF MOVEMENT OF DIMP-CONTAMINATED GROUNDWATER NEAR THE ROCKY MOUNTAIN ARSENAL, COLORADO,
Geological Survey, Lakewood, CO.
S. G. Robson.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 209-220, 3 fig, 2 ref.

Descriptors: *Computer models, *Simulation analysis, *Groundwater movement, *Path of pollutants, *Rocky Mountain Arsenal, *Colorado, *Groundwater pollution, *Diisopropylmethylphosphonate, Organic compounds, Chemical wastes, Industrial wastes, Seepage, Aquifers, Fate of pollutants, Model studies, Permeability.

Diisopropylmethylphosphonate (DIMP) is an organic compound produced as a by-product of the manufacture of a chemical munition at the Rocky Mountain Arsenal, Colo. Groundwater contamination occurred when industrial effluent containing DIMP seeped into the water table below unlined industrial waste-disposal ponds during 1952 to 1956. In 1975, groundwater containing DIMP was found in a 73 sq km area to the northwest of the arsenal and was detected within 1.6 km of municipal water wells supplying the city of Brighton, Colo. The DIMP concentrations in the groundwater ranged from 0.5 micrometers/L, the analytical detection limit, to as much as 44,000 micrograms/L near the abandoned waste disposal ponds. A mathematical model was used to simulate the movement and concentration of DIMP in groundwater near the arsenal to determine the historical distribution and concentration of the contaminant and to predict the possible future distribution of the contaminated groundwater. Model simulations of historical DIMP movement in the alluvial aquifer indicate that the contaminated groundwater flowed rapidly to the northwest and began discharging into the South Platte River about 4 years after the contaminant first entered the aquifer. It is estimated that from 1958 to 1960 the mean annual DIMP concentration was 30 microgram/L in the river. Modeling indicates that mean annual DIMP concentrations in the river have decreased since

the period 1958 to 1960 to < 1 microgram/L in 1976. Model simulations of future DIMP movement in the aquifer indicate that groundwater containing DIMP in excess of 0.5 microgram/L will not reach the Brighton municipal wells by 1995, even if no remedial measures are taken to prevent the discharge of DIMP-contaminated groundwater into an irrigation canal which recharges the aquifer near Brighton. A barrier impermeable to groundwater movement, is shown by the model to be an effective means of stopping off-arsenal movement of the contaminated groundwater without producing adverse effects on the water) levels in the aquifer. (See also W88-09434) (Author's abstract) W88-09446

ATTENUATION OF RADIONUCLIDES AND TOXIC ELEMENTS BY IN SITU SOILS AT A URANIUM TAILINGS POND IN CENTRAL WYOMING,

D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA.
S. Haji-Djafari, P. E. Antommaria, and H. L. Crouse.

IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 221-242, 9 fig, 5 tab, 9 ref.

Descriptors: *Radionuclides, *Path of pollutants, *Uranium, *Mine wastes, *Poisons, *Soil water, *Soil chemistry, *Wyoming, *Groundwater pollution, Ponds, Geohydrology, Mass transport, Model studies, Solute transport, Chemical precipitation, Ion exchange, Arsenic, Hydrogen ion concentration, Soil properties.

Existing concentrations of radionuclides and arsenic in a uranium tailings pond and groundwater, and geohydrologic and mass transport parameters were utilized in a Galerkin-based finite element mass transport model to predict future migration potential for discrete chemical species. Field and laboratory data and the results of computer modeling indicate that movement of chemical species of interest at the subject site is mitigated by chemical reaction with in situ soils including precipitation, coprecipitation, and ion exchange. The study showed that among the geohydrologic and mass transport parameters, distribution coefficients are the major controlling factor in determining the extent of attenuation of radionuclides and arsenic. These coefficients are specific to individual chemical species and are highly dependent on groundwater pH conditions and particular soil characteristics. (See also W88-09434) (Author's abstract) W88-09447

HUMAN VIRUSES IN SEDIMENTS, SLUDGES, AND SOILS.

CRC Press, Inc., Boca Raton, Florida. 1987. 241 p. Edited by V. Chalapati Rao, and Joseph L. Melnick.

Descriptors: *Viruses, *Sediments, *Sludge, *Fate of pollutants, *Wastewater treatment, *Disinfection, *Water quality, *Path of pollutants, *Public health, Monitoring, Temperature, Thermoresistance, Groundwater pollution, Hydrogen ion concentration, Adsorption, Organic matter, Ion exchange, Sludge drying, Pasteurization, Anaerobic digestion, Composting, Wastewater irrigation, Shellfish, Coliforms.

Wastewater and sludge treatment and disposal policies as currently practiced may result in the discharge of any of more than 120 human enteric virus pathogens into aquatic or terrestrial domains. Enteroviruses, including hepatitis virus A, reovirus, adenovirus, and rotavirus, Norwalk virus, and other gastroenteritis viruses have been detected in polluted water. Suspended solids-associated virus in raw sewage is partially transferred into sludge during sewage treatment. Virus concentrations of 5000 to 28,000 plaqque-forming units (pfu)/L are found in raw sludge, but are greatly reduced during treatment. An average of about 50 pfu/L can be expected in waste treatment plant effluents. Determination of the viral quality of recreational and shellfish waters by fecal coliform indexes is unsatisfactory. Direct application of wastewater or sludge to land carries a potential of viral pollution which may lead to contamination of crops and groundwater. Application by sprinkler irrigation introduces a risk of virus aerosols to exposed persons, particularly farm workers and those in nearby residential areas. Sludge treatment by drying, pasteurization, anaerobic digestion, and composting reduces but does not eliminate virus. Enteroviruses in sludge have survived 30 days of digestion at 50 C. Hepatitis A virus, which is even more thermoresistant, may be expected to survive for longer periods of time. Virus contamination of groundwater is influenced by the rate of application of wastewater and by soil composition and structure. Other factors include pH level, organic content, and ionic strength of the effluent. Low pH favors adsorption, while high pH results in elution. High concentrations of soluble organic matter in wastewater compete with viruses for adsorption sites on soil particles, resulting in decreased virus adsorption or even the liberation of previously adsorbed viruses. When wells are located in the vicinity of wastewater irrigation or land disposal sites, it would seem wise to prohibit their use as a source of drinking water pending test of water quality. Reasonable safety measures should include the siting of such wells at suitable distances from likely sources of contamination, and viral monitoring of water quality may have to be considered. (See W88-09464 thru W88-09476) (Lantz-PTT) W88-09463

ROLE OF SEDIMENT IN THE PERSISTENCE AND TRANSPORT OF ENTERIC VIRUSES IN THE ESTUARINE ENVIRONMENT,

University of Southern Mississippi, Hattiesburg. Dept. of Biology.
R. D. Ellender, J. B. Anderson, and R. B. Dunbar.

IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 37-55, 2 fig, 4 tab, 139 ref.

Descriptors: *Marine sediments, *Path of pollutants, *Viruses, *Estuaries, *Particulate matter, *Water currents, *Estuarine environment, Shellfish, Public health, Coastal waters, Recreation, Suspended solids, Prediction, Human diseases.

The public health significance of viruses in shellfish and coastal recreational waters is recognized, but the mechanisms of virus movement to recreational and shellfish harvesting waters and the persistence of virus infectivity in the estuarine environment remains poorly understood. Particulate matter in the water column plays a significant role in viral persistence and transport. There are differences and variations of the problem in coastal systems, and these differences can be traced to the virus type as well as the physical and chemical features of the individual estuarine ecosystems. A better understanding of this problem must include a comprehensive examination of the nature of the suspended particles, the circulation patterns of water, the influence of local fluvial discharges, the turbidity maximum, the chemistry and physics of virus adsorption to and elution from particulates, and the mechanisms of particulate settling from the water column. In addition, the nature and type of the virus particle, and the potential for human disease are important. The large number of agents of gastroenteritis which are difficult to grow or are presently uncultivatable must be examined from an environmental perspective. Future investigations of estuarine virology should aim to develop a multidisciplinary model of virus transport and persistence that will allow the prediction of potential public health problems. (See also W88-09463) (Lantz-PTT) W88-09466

VIRUS ASSOCIATION WITH SUSPENDED SOLIDS,

Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
V. C. Rao.

IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 57-75, 2 fig, 7 tab, 36 ref.

Descriptors: *Suspended solids, *Viruses, *Sediments, *Suspended sediments, *Public health, *Path of pollutants, *Adsorption, Cations, Organic matter, Distilled water, Estuaries, Proteins, Microbiological studies, Shellfish, Recreation, Elution, Laboratory methods, Virus recovery, Human diseases, Virus transport, Coastal waters.

Viruses adsorb effectively on clays as well as on solids collected from natural waters in laboratory studies. Inorganic suspended solids allow greater adsorption of viruses compared to volatile solids consisting of biological material. The cation content of a given water is very important to the adsorption process. Divalent cations on a molar basis provide greater virus adsorption than monovalent cations. Organic matter interferes with adsorption of virus on suspended solids by competing for adsorption sites. Adsorption of viruses on suspended solids was proven to be reversible. Eluents capable of recovering viruses from solids include distilled water; estuarine water; buffers such as tris, glycine, and borate saline; and proteinaceous media such as beef extract and TPB. Association with solids has no deleterious effect on a virus; on the other hand, the virus seems to be protected from natural inactivation in waters. Solids-virus association appears to be stable over a prolonged period, and only a change in the physicochemical characteristics would cause the virions to dissociate. Solids-associated viruses retain their infectivity to cell cultures over a prolonged period of time and also to mice by the oral route. This implies that viruses adsorbed on solids, when transmitted by contaminated water, can infect humans by the oral route. Viruses associated with solids, when introduced into coastal water, would assume the dispersal characteristics of solids and have ample opportunities of being transported from polluted waters to nonpolluted bathing beaches and shellfish beds, thereby causing a potential public health hazard. (See also W88-09463) (Lantz-PTT) W88-09467

BIOACCUMULATION AND DISPOSITION OF SOLIDS-ASSOCIATED VIRUS BY SHELLFISH,

Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
T. G. Metcalf.

IN: In: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 77-89, 23 ref.

Descriptors: *Fate of pollutants, *Viruses, *Bioaccumulation, *Shellfish, *Path of pollutants, Suspended solids, Public health, Estuarine environment, Human diseases, Water pollution treatment, Viral depletion, Epidemiology, Gastroenteritis, Hepatitis, Particulate matter, Estuaries.

Virus pollution of shellfish frequently, if not always, is the result of the association of virus with solids. Bioaccumulation of virus is associated with the uptake of particulates by feeding shellfish. Type A hepatitis and gastroenteritis illnesses are associated with the consumption of raw or inadequately cooked virus-polluted oysters, clams, and mussels. A number of species of shellfish are involved in the transmission of virus; it is likely that the actual incidence of shellfish-transmitted disease is much greater than the observed incidence. The solids-associated state is believed to be the vehicle responsible for virus survival and transport within an estuary and the means by which virus is brought to either water column or bottom sediment-water interface-feeding shellfish. Persistence of virus in shellfish and the effectiveness of depletion procedures is believed to depend upon factors that contribute to optimization of pumping and feeding functions plus location of virus shellfish. Virus carriage with subsequent release of infectious virus provides opportunities for transmission of virus to a number of potential life forms that live in the shellfish habitat. A carrier state may persist for months if the shellfish are dormant, representing a virus reservoir in nature from which infectious virus can be released weeks or months later. Actively pumping and feeding shellfish tend to eliminate alimentary tract-located virus within 48 to 72 hr. More time may be required for elimination of tissue-sequestered virus. Relaying and con-

trolled purification are effective bacterial or viral depletion procedures which reduce potential health risks but cannot guarantee pathogen-free shellfish. (See also W88-09463) (Lantz-PTT)
W88-09468

TRANSPORT AND FATE OF VIRUSES IN SOILS: FIELD STUDIES,
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
C. P. Gerba.
IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 141-154, 8 tab, 78 ref.

Descriptors: *Path of pollutants, *Viruses, *Fate of pollutants, *Field tests, *Land application, *Wastewater disposal, *Groundwater pollution, Model studies, Disposal sites, Site selection, Wells, Bacteria, Land disposal, Septic tanks, Landfills.

Improvements in technology during the 1970s for virus detection in the environment provided the tools for their study in soil and groundwater. Field studies clearly demonstrated the presence and persistence of enteric viruses in these environments. Through laboratory studies, insights have been gained into factors which control the survival and transport of viruses through soil systems. Almost all of the field studies on viruses in groundwater have been aimed at studying sites where intentional land application of wastewater was being practiced or have been conducted during water-borne disease outbreaks. The results of field studies on virus migration from septic tanks clearly indicate that viruses can travel substantial distances and survive extended periods of time in the subsurface. Where slow-rate land application of wastewater is conducted, viruses can migrate short distances from the source. Landfills are also potential sources of viruses because of the disposal of sewage sludges and baby diapers. Isolation of unidentifiable virus types from a groundwater observation well located 402 m down gradient from a sanitary landfill, have been reported. Field studies have clearly documented that virus contamination of groundwater also occurs in the absence of fecal indicator bacteria. Recent studies in England have clearly demonstrated that drinking water from a well with a long history of excellent bacteriological quality can contain significant levels of enteric viruses. More extensive field studies on viruses in drinking water wells are clearly needed to assess the exposure to potential contamination of drinking water supplies and valuable groundwater resources. (See also W88-09463) (Lantz-PTT)
W88-09473

SURVIVAL AND TRANSPORT OF VIRUSES IN SOILS: MODEL STUDIES,
North Carolina Univ. at Chapel Hill. School of Public Health.
M. D. Sobsey, and P. A. Shields.
IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 155-177, 4 tab, 106 ref.

Descriptors: *Viruses, *Path of pollutants, *Model studies, *Fate of pollutants, *Survival, *Soil contamination, Hydrogen ion concentration, Organic matter, Humic acid, Fulvic acid, Hydrogen ion concentration, Ions, Temperature, Soil water, Soil properties, Hydraulic loading, Flow rates, Groundwater movement, Saturated soils.

A variety of factors influence the survival and transport of viruses in soils. A major factor influencing virus survival is temperature, with generally increased survival at lower temperatures. Soil moisture also influences virus survival, with decreasing survival in dry or drying soils. Information in the literature is not entirely consistent regarding the moisture levels at which maximum virus inactivation occurs, and more studies are needed using a variety of viruses, soils, and moisture levels. Consideration should be given to measuring water activity as well as moisture levels, because the former may be more indicative of the effects of moisture on virus survival. Aerobic microbial activity also contributes to virus inactivation in soils at moderate to high temperatures. Although pH and ionic effects may play a role in virus inactivation in soils, these properties are related to the chemical and mineralogical characteristics of soils as well. Viruses differ in their ability to survive in soils, and more viruses must be evaluated to determine the overall range of virus survival. The role of organic matter in virus survival in soils is uncertain. Although interaction with humic and fulvic acids may cause reversible loss of virus infectivity, there is also some evidence that such virus complexation with organics may actually protect viruses from inactivation by preventing their adsorption to soil particles. Ionic conditions and pH also influence virus retention by soils, and retention is generally greater at lower pH levels and at higher salt concentrations or with salts having higher cation valences. Humic and fulvic acids interfere with virus retention by soils, and therefore both water and soils with high concentrations of these organics may be unsuitable for land application of wastewater. Increased hydraulic loads and flow rates may increase virus transport in soils, especially when the soils become saturated. (See also W88-09463) (Lantz-PTT)
W88-09474

VIRAL ASPECTS OF APPLYING SLUDGES TO LAND,
Metropolitan Sanitary District of Greater Chicago, IL.
For primary bibliographic entry see Field 5E.
W88-09475

INTERACTIONS BETWEEN VIRUSES AND CLAY MINERALS,
Nassau County Medical Center, East Meadow, NY.
S. M. Lipson, and G. Stotzky.
IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 197-230, 4 tab, 203 ref. EPA Grant Nos. R809067 and CR812484.

Descriptors: *Fate of pollutants, *Path of pollutants, *Viruses, *Clay, *Adsorption, Chemical reactions, Ion exchange, Sediments, Public health, Human diseases.

Clay minerals were suggested as adsorbents for viruses as early as the 1920s. However, it has only been within the last two decades that the mechanisms that mediate the adsorption of viruses on clays have been studied. It is now apparent that no single mechanism is responsible for the adsorption of all viruses on all clay minerals, although some mechanisms (e.g., hydrogen bonding, hydrophobic interactions, and anion or cation exchange) may predominate in many clay-virus systems. Adsorption of viruses on clay minerals appears to be the result of several interrelated mechanisms, each of which is dependent on the physicochemical characteristics of the adsorbent (i.e., the clay mineral) and the biophysical characteristics of the adsorbate (i.e., the virus). The persistence in and transmission of viruses through soils, sediment, and waters is related, in part, to their adsorption on clays and other particulates in these environments. An understanding of the mechanisms involved in these sorptive interactions is necessary to explain the behavior of pathogenic viruses in these environments and to enhance the efficacy of strategies to eliminate or decrease virus transmission to the human host. (See also W88-09463) (Lantz-PTT)
W88-09476

PROCEEDINGS OF THE FOURTH ANNUAL EASTERN REGIONAL GROUND WATER CONFERENCE.
For primary bibliographic entry see Field 4B.
W88-09477

MANAGEMENT OF TOXIC AND HAZARDOUS MATERIALS IN A ZONE OF CONTRIBUTION ON CAPE COD,
Massachusetts Dept. of Environmental Quality Engineering, Boston.
For primary bibliographic entry see Field 5G.
W88-09479

UPPER NEPONSET VALLEY AQUIFER STUDY: INTEGRATING GROUND WATER QUALITY PROTECTION WITH CONTAMINATION INVESTIGATIONS,
Massachusetts Dept. of Environmental Quality Engineering, Boston.
For primary bibliographic entry see Field 5G.
W88-09483

FLORIDA - PROVIDING INCENTIVE FOR REPORTING LEAKS,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5G.
W88-09484

CASE STUDY OF A LARGE SCALE PRECISION TANK TESTING PROGRAM,
Tetra Tech Richardson, Newark, DE.
For primary bibliographic entry see Field 5G.
W88-09486

DESIGN CONSIDERATIONS FOR UNDERGROUND STORAGE TANK INSTALLATIONS REQUIRING SECONDARY CONTAINMENT: A CASE STUDY,
Benatec Associates, Inc., Harrisburg, PA.
For primary bibliographic entry see Field 5G.
W88-09487

RISK DRIVEN SITE INVESTIGATIONS: TWO CASE STUDIES OF LEAKING UNDERGROUND STORAGE TANKS,
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5G.
W88-09488

APPLICATION OF THE SOIL-GAS SURVEY TO UNDERGROUND STORAGE TANK MONITORING AND LEAK DETECTION,
Hydrosystems, Inc., Falls Church, VA.
For primary bibliographic entry see Field 5A.
W88-09490

UNDERGROUND STORAGE TANK REMOVAL AND TREATMENT OF CONTAMINATED SOILS,
Law Environmental, Inc., Kennesaw, GA.
For primary bibliographic entry see Field 5G.
W88-09491

CORRECTIVE ACTION TECHNOLOGIES AND THEIR COST-EFFECTIVENESS,
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5G.
W88-09492

BIOLOGICAL TRACERS OF POLLUTION PLUMES FROM SEPTIC SYSTEMS,
Wisconsin Univ.-Madison. Water Resources Center.
For primary bibliographic entry see Field 5A.
W88-09493

CONTRIBUTION OF SELECTED TOXIC CHEMICALS TO GROUND WATER FROM DOMESTIC ON-SITE SEWAGE DISPOSAL SYSTEMS,
Connecticut Univ., Storrs. Dept. of Agricultural Engineering.
J. J. Kolega, D. W. Hill, and R. Laak.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 279-289, 2 fig, 9 ref.

Descriptors: *Path of pollutants, *Organic solvents, *Pollutant identification, *Groundwater pollution, *Organic compounds, Water quality, Leachates, Leaching, Toxic wastes, Organic wastes, Domestic wastes, Wastewater disposal, Connecticut.

A multi-disciplinary study was conducted to evaluate the movement of household toxic chemical discharges from the conventional on-site sewage disposal system into the surrounding groundwater. Organic solvents and volatile organic compounds were analyzed in Connecticut domestic sewage disposal systems in four single family residences, three condominiums, a community on-site sewage disposal system, and a single family residence served by the RUCK denitrification system. Results are given in tables showing sites, the number of samplings made, and pollutants observed in the samples collected from the groundwater monitoring wells for Brookfield, Chester and Coventry, Connecticut. The volatile organic compounds and hydrocarbons detected in groundwater samples taken from Monroe and Somers, Connecticut are also listed. Volatile organic compounds and hydrocarbons were found to make their way into the groundwater area near the on-site sewage disposal systems. Further groundwater studies near on-site sewage disposal sites are recommended. (See also W88-09477) (Geiger-PTT)
W88-09494

IS PRIVATE WELL PROTECTION ADEQUATE WHEN GROUND WATER FLOW IS IGNORED,
K-V Associates, Inc., Falmouth, MA.
For primary bibliographic entry see Field 5G.
W88-09495

INFLUENCE OF AGRICULTURAL PRACTICES ON GROUND WATER QUALITY IN MAINE,
Maine Geological Survey, Augusta.
J. S. Williams, C. D. Neil, and T. K. Weddle.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 329-341, 3 tab, 18 ref.

Descriptors: *Pesticides, *Agricultural runoff, *Groundwater pollution, *Wells, *Path of pollutants, Water pollution sources, Arsenic, Pesticide residues, Nitrates, Carbamate pesticides, Organophosphorus pesticides, Pollutant identification.

In 1985, the State of Maine began a three year evaluation of the effects of agricultural practices on groundwater quality. In the first two years, water samples were collected from 59 overburden and 26 bedrock wells in areas heavily used for potato, blueberry, market crop, and apple production. Thirty-seven percent of the wells sampled in potato areas have had detectable pesticide levels. Pesticides detected include methamidophos, metribuzin, dinoseb, endosulfan, ETU, dicamba, chlorothalonil, and pichloram. Methamidophos was most frequently found (10 wells), and was found in the highest concentration, 0.09 to 10.5 micrograms per liter (ug/l). Hexazinone (7 and 9 ug/l) was found in 2 wells in blueberry areas; arsenic (0.037 mg/l) was found in an orchard well; and alachlor (0.19 ug/l) and atrazine (0.4 ug/l) were found in different wells near market gardens. No other pesticides were detected in these areas. Nitrate levels exceeding 10 mg/l (asN) were found in 19 of the 85 wells sampled. Mean nitrate levels were highest in market garden areas (8 mg/l), and lowest in areas used for blueberry cultivation (0.1 mg/l). Pesticides were detected in 58% of the bedrock wells sampled; only 20% of the overburden wells had detectable pesticide contamination. Bedrock wells also had higher mean nitrate levels than overburden wells (8.6 mg/l vs. 4.3 mg/l). A higher percentage of wells with detectable pesticide levels were found in areas overlain by till than were found in sand and gravel areas. It should be noted that the pesticide concentrations found in this study have been very low (0.02 to 37 ug/l). Of 188 samples taken in the study to date, only one contained pesticide (dinoseb) concentrations above an established health standard (2 ug/l), and only three exceeded statistically sound levels of detection. Because the samples were chosen to define the worst case situation, pesticides do not appear to be a widespread threat to groundwater quality in Maine. (See also W88-09477) (Author's abstract)
W88-09497

FLUX OF NITRATE NITROGEN BENEATH A CONNECTICUT CORN FIELD,
Ground Water, Inc., Middlestown, CT.
P. A. Marin.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 343-369, 16 fig, 3 tab, 5 ref.

Descriptors: *Nitrates, *Nitrogen, *Groundwater pollution, *Groundwater movement, *Agricultural chemicals, *Path of pollutants, Test wells, Fertilizers, Corn, Connecticut, Water pollution sources, Geohydrology.

Elevated levels of nitrate nitrogen in groundwaters in Connecticut are often associated with areas of extensive silage corn cultivation. 200 acre corn silage farm in Middlefield, Connecticut which may be contributing to or causing elevated nitrate nitrogen levels (> 10 ppm) in nearby private residential water supply wells was studied. All of the water wells are drilled into the underlying bedrock, a siltstone and sandstone of Triassic Age called the New Haven Arkose. Overburden material is primarily a sandy to silty glacial till deposit. The purpose of this study is to define and understand the hydrogeologic and groundwater characteristics of the farm and nearby adjacent areas. Of specific concern is the probable duration of elevated nitrate nitrogen concentrations in water supply wells given rates of groundwater flow and the sources of nitrate nitrogen in the area. This study began in the fall of 1986. Twenty-one test borings were conducted on the site in October and November, 1986. Monitor wells were placed in each test boring. Five of the borings were drilled deep into the underlying arkose. The rest of the borings and wells (16) were installed in the overburden above competent bedrock. Packer tests were conducted in the bedrock test borings to identify and define fracture zones and the water yielding characteristics of the fractures encountered. Water quality samples for nitrate nitrogen analysis are collected monthly from all monitor wells and nearby water suppply wells. Groundwater levels are measured from each monitor well monthly and three times a week from a selected deep, shallow monitor well pair. The water quality data obtained thus far indicates widely variable nitrate nitrogen levels in the farm area but relatively little variability in nitrate nitrogen levels in downgradient water supply wells. (See also W88-09477) (Author's abstract)
W88-09498

GROUND WATER CONTAMINATION FROM THE AGRICULTURAL USE OF ETHYLENE DIBROMIDE (EDB) IN SIMSBURY, CONNECTICUT,
Ground Water, Inc., Middlestown, CT.
E. X. Droste.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 371-401, 11 fig, 5 tab, 6 ref.

Descriptors: *Pesticide residues, *Ethylene dibromide, *Leaching, *Path of pollutants, *Groundwater pollution, Connecticut, Insecticides, Pesticides, Adsorption, Degradation, Monitoring, Soil contamination, Test wells, Agricultural chemicals, Leachates.

A residential area in Simsbury, Connecticut has groundwater contaminated by 1,2-dibromoethane (EDB), a potential human carcinogen. In a cooperative effort between the State of Connecticut Department of Environmental Protection (DEP) and the Connecticut Agricultural Experiment Station (CAES), a joint investigation of this site was conducted in May of 1985 to delineate the extent of contamination and estimate its duration. The CAES studied the degradation and adsorptive qualities of EDB in the laboratory. The DEP conducted a field investigation and monitoring program to determine the extent and amount of contamination of the site. Integrating the results from the DEP and CAES investigations, the objectives of the study were achieved. It was concluded that EDB still exists in the soil and groundwaters of the site in Simsbury. The contamination was most likely due to former agricultural practices documented in the mid to late 1960's. EDB is expected to continue to persist in groundwaters in this area due to the reservoir of EDB remaining in the upper 2 feet of soil throughout the study area. This reservoir will continue to leach out minute quantities of EDB at a rate that may still be hazardous to human health via drinking water exposure. (See also W88-09477) (Geiger-PTT)
W88-09499

PREPARATION OF A BEDROCK RIFS (BRIFS) ALLOWS FOR UNPREDICTABLE FLOW IN FRACTURED ROCK,
Quest Environmental Sciences, Inc., Manchester, NH.
For primary bibliographic entry see Field 2F.
W88-09500

CHEMO-HYDROGEOLOGIC TRANSPORT OF CONTAMINANTS IN GLACIAL-FLUVIAL DEPOSITS: A SITE INVESTIGATION,
Camp, Dresser and McKee, Inc., New York.
E. F. Dul, J. McGahren, J. Bryson, and S. Theal.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 491-514, 18 fig, 4 tab, 2 ref.

Descriptors: *Hazardous wastes, *Path of pollutants, *Groundwater pollution, *Drinking water, *Groundwater movement, Aquifers, Test wells, Monitoring, Soil contamination, Organic compounds, Water pollution control, Fate of pollutants, Water pollution prevention, Leaching, Geohydrology.

Under the auspices of the U.S. Environmental Protection Agency (EPA), an in-situ investigation, supplemented by laboratory leaching tests of contaminated site soils, was performed to estimate the release, transport, and fate of tetrachloroethylene (perchloroethylene, PCE) at a hazardous waste site. The study documents the source-pathway-receptor relationship that resulted in contamination of an infiltration municipal drinking water well. To determine the nature and extent of contamination, a phased series of borings and groundwater monitoring wells were installed and the associated soil and groundwater samples analyzed for priority pollutants. The contaminant pathway was estimated by simultaneously observing water quality parameters in the municipal well, a nearby reservoir, and monitoring wells while pumping the municipal well. To estimate contaminant desorption from area soils, contaminated soil samples from glacial outwash deposits were leached with site background water. The study demonstrates the quantitative relationship among a contaminant source, pathway, and receptor and provides the basis for remedial action. The paper describes the multidisciplinary methods used in the office, field, and laboratory to define quantitatively the temporal and spatial chemo-hydrogeological relationships at the site. (See also W88-09477) (Author's abstract)
W88-09504

USE OF SEDIMENT PERMEABILITY VARIATIONS IN THE PERFORMANCE OF PETROLEUM RECOVERY FROM GLACIAL SEDIMENTS,
Groundwater Technology, Inc., Norwood, MA.
R. M. Gailey, and D. E. Jones.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 515-525, 8 fig, 4 ref.

Descriptors: *Oil recovery, *Groundwater pollution, *Oil pollution, *Water pollution treaatment, *Glacial sediments, *Path of pollutants, *Cleanup operations, Leakage, Fuel, Massachusetts, Permeability, Monitoring, Test wells, Water pollution prevention.

A hydrogeologic investigation was performed in response to a release of diesel fuel into the subsurface at a site located in western Massachusetts. Approximately 20,000 gallons of fuel were pumped into the soil overnight. The circumstances of the release indicated that there was probably a long-term, undetected leak at the site prior to discovering the release. The soil stratigraphy at the site is composed of glacial till, as well as glacio-fluvial and glacio-lacustrine deposits. The configuration of these sediments significantly influenced petroleum migration pathways at the site. Ultimately, free-floating petroleum accumulated on the water table hydraulically upgradient of the contaminant source location. The petroleum then migrated parallel to the groundwater contours. The goal of the initial hydrogeologic investigation was to define the areal extent of the free-floating plume. A dense pattern of monitoring wells was installed in order to accomplish this task. Concurrent with completion of this investigation, petroleum was recovered from monitoring wells located in the interior of the plume. Full-scale recovery of the diesel fuel is currently under way. The recovery system was designed to utilize the heterogeneity of the glacial deposits to improve system efficiency and to reduce project costs. A combination of migration control, petroleum recovery and recharge wells is being used to effectively contain and recover the petroleum. Approximately 25,000 gallons of fuel have been recovered and recycled within one year of discovering the leak. Field data indicate that a significant volume of potentially recoverable petroleum still remains in the subsurface. (See also W88-09477) (Author's abstract)
W88-09505

SITE SPECIFIC PREDICTIVE METHOD FOR REGULATING LEACHABLE PESTICIDES,
Geraghty and Miller, Inc., Tampa, FL.
F. A. Jones, G. Chesters, and J. M. Harkin.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 529-543, 4 tab, 12 ref.

Descriptors: *Pesticides, *Path of pollutants, *Leaching, *Groundwater pollution, Model studies, *Water pollution prevention, Leachates, Pesticide residues, Wisconsin, Water quality, Agricultural runoff, Unsaturated zone, Groundwater movement.

Identification of economically important pesticides in the groundwater of several regions of the country at concentrations of toxicological significance has necessitated development of new regulatory strategies. Inherent within these strategies is the capacity to predict where applications of a leachable pesticide will result in residue concentrations in the groundwater exceeding criteria established to protect public health. Two methods were developed to identify agricultural fields where the application of leaching pesticides would result in unacceptably high groundwater residue concentrations. The first method was adapted from the national groundwater susceptibility evaluation scheme (DRASTIC) and was designed for use in Wisconsin. The second method utilizes a deterministic mass balance unsaturated-zone model developed by the EPA (PRZM). The modified DRASTIC scheme was based upon a weighted score for several environmental media and depth parameters, while the PRZM is based upon calculation of leachate mass as a function of depth to groundwater. Assessment of the predictive capabilities of the two methods indicated that the modified DRASTIC method provided gross overestimations of site susceptibility which resulted in erroneous identification of moderately susceptible sites. The PRZM method also showed a tendency to overestimate site susceptibility; however, the degree of overestimation was considerably lower and predictions were more accurate than the modified DRASTIC method. Unsaturated-zone models provided an effective means of identifying sites where applications of leaching pesticides will have minimal impacts upon groundwater quality. (See also W88-09477) (Author's abstract)
W88-09506

INTERPRETATION OF EM DATA THROUGH GEOELECTRIC MODELING WITH APPLICATION TO A LANDFILL IN SOUTHEASTERN NEW HAMPSHIRE,
Normandeau Engineers, Inc., Concord, NH
For primary bibliographic entry see Field 5A.
W88-09510

USE OF PORTABLE PHOTOIONIZATION METERS TO ASSESS THE LATERAL AND VERTICAL DISTRIBUTION OF CONTAMINANTS AT HAZARDOUS WASTE FACILITIES: A CASE STUDY,
Dunn Geoscience Corp., Albany, NY.
For primary bibliographic entry see Field 5A.
W88-09511

LEVANT INVESTIGATION: USING RADIOCARBON DATING TO DETERMINE THE SOURCE OF METHANE GAS CONTAMINATION,
New York State Dept. of Environmental Conservation, Albany.
J. L. Hewitt.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 649-662, 4 fig, 1 tab, 9 ref.

Descriptors: *Methane, *Groundwater pollution, *Water pollution sources, *Carbon radioisotopes, *Radioactive dating, *Pollutant identification, Path of pollutants, Wells, Wetlands, Landfills, Leakage.

The Levant, New York investigation began on November 2, 1983, when an explosion blew the door off the enclosed pit which housed a residential water well pump. During the next few months, thirteen additional homes in the Levant area of Chautauqua County were identified with combustible levels of methane gas emanating from their yards and water wells. Possible sources for the gas included leaking gas transmission lines, naturally-occurring shale gas, deep gas wells drilled during the past year on a nearby hillside, oil wells drilled in the early 1900's, and a nearby wetland which had been partially filled with construction and demolition debris. To help determine the source of the gas, samples were subjected to radiocarbon dating from three known sources and four affected residences. Although the hydrogeologic setting seemed to favor the landfill and wetland as the source of the natural gas affecting residences in Levant, radiocarbon dating clearly indicated that this was not so. Present investigations are focused on other probable sources. (See also W88-09477) (Geiger-PTT)
W88-09512

INFLUENCE OF OTHER GASOLINE DERIVED ORGANICS ON THE BEHAVIOUR OF DISSOLVED MONOAROMATICS IN GROUND WATER,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
K. L. Berry-Spark, G. C. Patrick, J. F. Barker, D. Major, and C. I. Mayfield.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 665-680, 5 fig, 5 tab, 13 ref.

Descriptors: *Aromatic compounds, *Fate of pollutants, *Groundwater pollution, *Sand aquifers, *Biodegradation, *Path of pollutants, Sorption, Gasoline, Injection wells, Benzenes, Hydrocarbons.

Two field injection experiments were conducted to investigate the fate of monoaromatic hydrocarbons in ground water in a shallow sand aquifer at Canada Forces Base Borden. The first experiment involved the injection of ground water containing benzene, toluene, and xylene isomers (BTX) only. A later injection of ground water containing benzene, toluene, ethyl benzene, and xylenes (BTEX) derived from gasoline was also performed as part of an in situ aquifer restoration study. Preliminary results of this restoration experiment will be discussed. When water is contacted by gasoline, several other organic compounds in addition to BTEX, dissolve into the water. The effect of these compounds on the biodegradation and mobility of BTEX is determined by comparing the results of the two experiments. Synoptic three-dimensional solute distributions were determined at discrete time intervals. From this distribution data, estimates of the mass of aromatics remaining in solution and the centers of mass were made. The effect of other gasoline constituents on the sorption and biodegradation of the monoaromatics appears minimal. Laboratory studies with Borden sand and groundwater containing either BTX alone or gasoline-derived BTEX were conducted to further investigate the role of other gasoline constituents in the biodegradation of the monoaromatics. Aerobic transformation rates are comparable to those determined from the field experiments. The presence of non-BTEX compounds derived from gasoline appeared to significantly alter the aerobic biodegradation of BTEX. This discrepancy with the field observations likely reflects the inability of static laboratory experiments to duplicate dynamic field conditions. (See also W88-09477) (Author's abstract)
W88-09513

REMEDIATION OF GASOLINE CONTAMINATED GROUND WATER BY INFILTRATION THROUGH SOIL,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5G.
W88-09514

INNOVATIVE AQUIFER RESTORATION TECHNIQUES AT A SITE IN NORTHERN VERMONT CONTAMINATED BY GASOLINE HYDROCARBONS,
Groundwater Technology, Inc., Albany, NY.
For primary bibliographic entry see Field 5G.
W88-09515

EFFECTIVE USE OF A LATERALLY EXTENDED WELL HYDROCARBON RECOVERY IN LOW PERMEABILITY SEDIMENTS ALONG A RIVER,
Johnson Co., Inc., Montpelier, VT.
For primary bibliographic entry see Field 5G.
W88-09516

COMPARATIVE VULNERABILITY TO OIL SPILLS OF BEDROCK VERSUS SAND AND GRAVEL AQUIFERS,
Maine Dept. of Environmental Protection, Augusta.
For primary bibliographic entry see Field 5C.
W88-09520

MODELS OF SORPTIVE TOXIC SUBSTANCES IN FRESHWATER SYSTEMS: I. BASIC EQUATION,
Manhattan Coll., Bronx, NY. Dept. of Environmental Engineering and Science.
D. J. O'Connor.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 507-532, June 1988. 5 fig, 43 ref, 6 append. Nation Science Foundation Grant CEE82-07319, EPA Grant 807827.

Descriptors: *Toxic wastes, *Path of pollutants, *Sorption, Solute transport, Model studies, Mathematical models, Partition coefficient, Equilibrium, Particulate matter, Suspended solids, Sediments, Radioactive wastes, Pesticides, Organic compounds, Heavy metals.

Equations that define the steady-state distribution of solids and sorptive chemicals in freshwater systems were developed. Instantaneous equilibrium between the dissolved and particulate components of the compound was assumed for various partitioning functions. Solutions were developed for both solids-dependent and solids-independent partitioning. The exchange of the suspended and bed solids, in conjunction with the transfer and kinetic pathways of the dissolved and particulate compo-

nents of the chemical, was taken into account. The relationships among these variables were successively reduced to a single differential equation, an analytical solutions of which was developed. The exchange coefficients of both the dissolved and particulate components of the chemical between the water column and bed were key factors, for which guidelines were developed. The equations were developed for batch systems, which provided the basis for the subsequent developments in freshwater systems. (See also W88-09523 and W88-09524) (Author's abstract)
W88-09522

MODELS OF SORPTIVE TOXIC SUBSTANCES: II. LAKES AND RESERVOIRS,
Manhattan Coll., Bronx, NY. Dept. of Environmental Engineering and Science.
D. J. O'Connor.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 533-551, June 1988. 5 fig, 1 tab, 11 ref, 2 append. National Science Foundation Grant CEE82-07319, EPA Grant 807827.

Descriptors: *Toxic wastes, *Path of pollutants, *Sorption, *Lakes, *Reservoirs, Solute transport, Model studies, Mathematical models, Partition coefficient, Particulate matter, Equilibrium, Suspended solids, Sediments, Lindane, DDE, Pesticides, Plutonium, Radioactive wastes, Heavy metals, Metals, Organic compounds, Radioisotopes.

Equations defining the distributions of suspended solids and sorptive substances in completely mixed lakes and reservoirs were developed and solved analytically. The relevant transport, transfer, and kinetic pathways were incorporated in the analysis of toxic chemicals for the condition of instantaneous equilibrium between the dissolved and particulate components. For this condition, the total concentration of the chemical was defined for the water column and bed, the equations for which were solved simultaneously. The partition coefficient and the concentration of solids yielded the distribution between the dissolved and particulate components. The suspended solids relations, which are related to the trap efficiency of reservoirs, provided a necessary factor for the equations of the sorptive substances. The solutions of the differential equations were applied to the steady-state and time-variable conditions in lakes and reservoirs for various hydrological and mass input conditions. (See also W88-09522 and W88-09524) (Author's abstract)
W88-09523

MODELS OF SORPTIVE TOXIC SUBSTANCES IN FRESHWATER SYSTEMS: III. STREAMS AND RIVERS,
Manhattan Coll., Bronx, NY. Dept. of Environmental Engineering and Science.
D. J. O'Connor.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 552-574, June 1988. 9 fig, 2 tab, 10 ref, 3 append. National Science Foundation Grant CEE82-07319.

Descriptors: *Toxic wastes, *Path of pollutants, *Streams, *Rivers, *Sorption, Solute transport, Model studies, Mathematical models, Partition coefficient, Equilibrium, Particulate matter, Suspended solids, Sediments, Wastewater disposal, Heavy metals, Metals, Flint River, Michigan, Zinc, Clinton River, Nickel, Hudson River, New York, Polychlorinated biphenyls.

Equations defining the steady-state distributions of solids and sorptive substances in freshwater streams and rivers were developed and solved analytically. The spatial variations for the flow and suspended solids were incorporated in the chemical equations, which took into account the kinetic and transfer routes of the dissolved and particulate components. The sorptive interaction between these components was characterized by instantaneous equilibrium. The solution for the total concentration of the chemical from which the dissolved and particulate components follow, was developed. Various relationships between the partition coefficient and the solids were incorporated into the equations. The exchange of both the dissolved and particulate components of the chemical between the water column and the bed is a key factor. The calculated spatial profiles of heavy metals and organic chemicals were compared to observed data under different flow and wastewater discharge conditions in the freshwater rivers. (See also W88-09522 and W88-09523) (Author's abstract)
W88-09524

EVALUATION OF MOBILITY OF PESTICIDES IN SOIL USING U.S. EPA METHODOLOGY,
Utah Water Research Lab., Logan.
J. E. McLean, R. C. Sims, W. J. Doucette, C. R. Caupp, and W. J. Grenney.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 689-703, June 1988. 6 tab, 50 ref, 2 append. EPA Grant CR-810979.

Descriptors: *Path of pollutants, *Pesticides, *Soil contamination, Insecticides, Toxaphene, Model studies, Mathematical models, Endosulfan, Aldrin, Heptachlor, Disulfoton, Phorate, Parathion, Methylparathion, Organophosphorus pesticides, Halogenated pesticides, Mass transport.

The potential mobility of eight chlorinated and organophosphorus pesticides was evaluated in soil system. First-order degradation constants were determined by soil treatability studies. Partition coefficients among water, soil, and air phases were calculated. These data were used as input in a finite difference mathematical model to evaluate mass transport potential, including amount and extent of movement through environmental pathways to ground water and to the atmosphere. Model output indicated that no significant migration to the groundwater or atmosphere was likely. The model-predicted leaching potentials (concentration in soil water/concentration in soil) were as follows: disulfoton, 330; phorate, 23; methylparathion, 4.8; toxaphene, 0.5 endosulfan, 0.12; parathion, 0.06; heptachlor, 0.06; and aldrin, 0.0009. (Cassar-PTT)
W88-09532

ORGANIC CONTAMINANTS IN ADULT AQUATIC INSECTS OF THE ST. CLAIR AND DETROIT RIVERS, ONTARIO, CANADA,
Windsor Univ. (Ontario). Dept. of Biology.
J. J. H. Ciborowski, and L. D. Corkum.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 148-156, 1988. 1 fig, 4 tab, 23 ref.

Descriptors: *Path of pollutants, *Rivers, *Aquatic insects, *Organic compounds, Insects, St. Clair River, Detroit River, Ontario, Caddisflies, Chlorinated hydrocarbons, Polychlorinated biphenyls.

Trichoptera and Ephemeroptera were collected from 8 Canadian sites adjacent to the St. Clair and Detroit Rivers. Significant concentrations of chlorinated hydrocarbons (pentachlorobenzene, hexachlorobenzene, octachlorostyrene, and 16 polychlorinated biphenyl cogeners) were found in extracts from these insects. Principal component analysis accounted for 84% of variation in contaminant concentration among samples. The principal components correlated highly with concentrations of 9 hexa-, hepta-, and octachlorobiphenyls (46% of overall variation), 4 tetra- and pentachlorobiphenyls (17% of variation), the chlorobenzenes and octachlorostyrene (8% of variation), and 2 trichlorobiphenyls (each 6% of variation). Insects from the Detroit River had significantly more hexa-, hepta-, and octachlorobiphenyls than insects from the St. Clair River. The levels of tetra- and pentachlorobiphenyls were highest in the upstream stations of both rivers. Levels of the chlorobenzenes and octachlorostyrene were higher in St. Clair River samples than in Detroit River samples. The results were consistent with results of biota and sediment sampling previously done. Contaminant levels varied among taxa collected from the same site, possibly because of different larval feeding habits or microdistribution, or adult flight ability. This method has potential as an inexpensive alternative to aquatic sampling methods. (Cassar-PTT)
W88-09548

TRACE ELEMENT CONCENTRATIONS IN NEAR-SURFACE WATERS OF THE GREAT LAKES AND METHODS OF COLLECTION, STORAGE, AND ANALYSIS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 7B.
W88-09553

FACTORS AFFECTING METAL PARTITIONING DURING RESUSPENSION OF SEDIMENTS FROM THE DETROIT RIVER,
Clarkson Univ., Potsdam, NY. Dept. of Civil and Environmental Engineering.
T. L. Theis, T. C. Young, and J. V. DePinto.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 216-226, 1988. 7 fig, 7 tab, 18 ref. EPA Grant CR812570.

Descriptors: *Path of pollutants, *Rivers, *Sediment transport, *Heavy metals, Metals, Detroit River, Cadmium, Cobalt, Copper, Nickel, Lead, Zinc, Particulate matter, Sediment-water interfaces, Sorption, Bottom currents, Water currents.

Sediment cores from three stations in the Trenton Channel of the Detroit River were artificially resuspended. Statistical analysis of the data indicated that the concentrations of the dissolved metals Cd, Co, Cu, Ni, Pb, and Zn in the overlying water varied inversely with pH and directly with time when the pH was below 7.5. In addition, dissolved metals were consistently lower at the higher frequency of mixing. Only Zn showed a direct correlation between total and dissolved concentrations although all other metals revealed an increased positive correlation at the higher mixing rate. These results were interpreted in terms of surface sorption reactions, particle size distributions, and mass transfer controls on metal-sediment reaction rates. (Cassar-PTT)
W88-09555

SUMMARY OF SURFACE AND BACKGROUND CONCENTRATIONS OF SELECTED ELEMENTS IN THE GREAT LAKES SEDIMENTS,
National Water Research Inst., Burlington (Ontario).
A. Mudroch, L. Sarazin, and T. Lomas.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 241-251, 1988. 3 fig, 2 tab, 5 ref.

Descriptors: *Path of pollutants, *Lakes, *Literature reviews, *Heavy metals, *Sediments, Metals, Dredging, Trace elements, Bottom sediments, Great Lakes, Arsenic, Cadmium, Copper, Chromium, Iron, Lead, Mercury, Nickel, Zinc, Lake sediments, Sampling, Pollutant identification, Lake Erie, Lake Ontario, Lake Michigan, Lake Huron, Lake Superior, St. Clair Lake.

A literature survey was carried out to obtain recent and background concentrations of selected elements (As, Cd, Cu, Cr, Fe, Ni, Pb, Zn, and Hg) in the sediments from different areas of the Great Lakes. This information was required for the revision of the guidelines for the disposal of dredged material at the Canadian side of the Great Lakes. Surveyed literature included articles published during the past 15 years in different scientific journals and governmental and U.S. and Canadian universities reports. Large differences in concentrations of selected elements reported in the Great Lakes sediments reflected different sampling localities and techniques, and methods used for sediment analyses. Concentration ranges reported for surveyed elements were wider for the surface sediments of the depositional basins than those for the pre-colonial sediments. The results of the literature search indicated the need for development of a standard sediment sampling protocol and standard analytical procedures for the assessment of contamination of the sediments at different areas of the Great Lakes. (Author's abstract)
W88-09558

PRESENCE AND PERSISTENCE OF LISTERIA MONOCYTOGENES IN FOOD AND WATER,

Georgia Experiment Station, Griffin.
R. Brackett.
Food Technology FOTEAO, Vol. 42, No. 4, p 162-164, 178, April 1988. 1 fig, 2 tab, 41 ref.

Descriptors: *Listeria monocytogenes, *Listeria, *Foods, *Bacteria, *Path of pollutants, *Food processing industry, *Human diseases, *Contamination, Wastewater, Diseases, Shellfish, Public health, Wastewater disposal, Land application.

A brief review of the nature and presence of Listeria Monocytogenes in the environment and how that presence may result in the contamination of foods and human disease is presented. General characteristics, habitats, and hosts are discussed. The various routes of transmission of this pathogen are given. L. monocytogeses has been associated with man, domestic and wild mammals, fish and shellfish, and birds. Fecal contamination of water and soil (possibly via land application of sewage or sewage effluents) could lead to contamination of fruits, vegetables, fish, and shell fish, thus transmitting infection. The fact that listeria is widespread in the environment and in domestic animals makes it very unlikely that the food industry can avoid contact with this bacterium. The author states that commonsense approaches toward minimizing contamination or eliminating L. monocytogenes from foods will do much to protect the public from listeriosis. (Stoehr-PTT)
W88-09563

USE OF POLLUTANT AND BIOGENIC MARKERS AS SOURCE DISCRIMINANTS OF ORGANIC INPUTS TO ESTUARINE SEDIMENTS,
Institute for Marine Environmental Research, Plymouth (England).
J. W. Readman, R. F. C. Mantoura, C. A. Llewellyn, M. R. Preston, and A. D. Reeves.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 1+2, p 29-54, October 1986. 8 fig, 3 tab, 47 ref. NERC Grant GST/02/45.

Descriptors: *Spatial distribution, *Water analysis, *Path of pollutants, *Estuaries, *Hydrocarbons, Water pollution sources, *Sediments, Organic compounds, Fate of pollutants, United Kingdom, Tamar Estuary, Pigments, Computers, Chromatography, Spectrophotometry, Mass spectorscopy.

The estuarine distributions of a variety of molecular organic markers re described and discussed in relation to sources, transport mechanisms and fates of anthropogenic and biogenic inputs to Tamar Estuary, U.K. Components selected for study include hydrocarbons (saturated and polycyclic aromatics), sterols, lignins and photosynthetic pigments. To investigate the complex inter-relationships between the components, selected statistical techniques including cluster analysis and multidimensional scaling are introduced. Techniques used in the analyses of markers include preparative thin-layer chromatography, and high performance liquid chromatography (HPLC); quantification by HPLC-UV/fluorescence and capillary gas chromatography-flame ionization detection with identification by HPLC-rapid scanning diode array spectrophotometry and computerized capillary gas chromatography-mass spectroscopy. (Author's abstract)
W88-09566

DEVELOPMENTS IN THE SPECIATION AND DETERMINATION OF ALKYLMETALS (SN, PB) USING VOLATILIZATION TECHNIQUES AND CHROMATOGRAPHY-ATOMIC ABSORPTION SPECTROSCOPY,
New Hampshire Univ., Durham. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W88-09567

ANALYSIS AND FATE OF DIBENZOTHIOPHENE DERIVATIVES IN THE MARINE ENVIRONMENT,
Centre National de la Recherche Scientifique, Brest (France). Lab. de Chromatographie.
F. Berthou, and V. Vignier.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 1+2, p 81-96, October 1986. 6 fig, 3 tab, 33 ref. Institut Francais du Petrole contract number 7404.

Descriptors: *Chemical analysis, *Chromatography, *Oil pollution, *Oxidation, *Fate of pollutants, *Marine environment, *Water pollution sources, France, Oil spills, Rats, Metabolism, Enzymes.

Dibenzothiopene (DBT) and related methylated derivatives are known to be among the most persistent and probably the most toxic polycyclic aromatic hydrocarbons (PAHs) in the marine environment. This study aimed to provide the necessary base line data for proper evaluation of the fate of DBT and related alkylated derivatives in the marine environment. Three kinds of results are reviewed in this article: (1) chromatographic separation of methyl and dimethyl DBT isomers and their use as organic markers of oil pollution, (2) fate of DBT and methylated derivatives in a controlled marine environment under natural irradiation, and (3) in vitro metabolism of DBT by rat microsomes. In the first case, the relative distribution of four monomethyl DBT enabled the determination of the source of pollution in an oyster-area in the North Brittany (France). In the second case, the fate of methylated DBT compounds was studied in a controlled seawater enclosure where Arabian light oil was spilled. In the third case, rat microsomes transformed the substrate into DBT-5-oxide and subsequently into DBT-5-dioxide. (Miller-PTT)
W88-09568

CONCENTRATIONS OF DIOXINS AND DIBENZOFURANS IN THE ATMOSPHERE,
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
B. D. Eitzer, and R. A. Hites.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 3, p 215-230, November 1986. 6 fig, 22 ref. Department of Energy Grant 80EV-10449.

Descriptors: *Dioxins, *Benzenes, *Aromatic compounds, *Path of pollutants, *Precipitation, *Chemistry of precipitation, *Water pollution sources, Gas chromatography, Mass spectrophotometry, Sinks, Rain, Particulate matter.

Polychlorinated dibenzo-p-dioxins and dibenzofurans have been found in environmental sinks such as lake sediments and human fat. This report examines the transportation and depositional media of these compounds by analyzing ambient air and rain samples. Air was sampled with a high volume sampler and split into operationally defined particulate and vapor phases with a glass fiber filter and a polyurethane foam plug. rain was sampled with a one square meter wet-only collector. The analytical methodology is based on a two step chromatographic clean-up followed by negative ion gas chromatographic mass spectrometry. Concentrations of the different congeners in the samples were 1 to 750 femtograms per cubic meter of ambient air for the vapor and particulate samples. Concentrations of the rain samples were in the picogram per liter range. These are the first measurements of these compounds in ambient air and rain samples. The concentrations in these samples were used to determine vapor/particulate ratios and to compare vapor and particulate scavenging by rain. (Author's abstract)
W88-09570

DETERMINATION OF 'HEAVY' ORGANOTIN POLLUTION OF WATER AND SHELLFISH BY A MODIFIED HYDRIDE ATOMIC ABSORPTION PROCEDURE,
Universite de Pau et des Pays de l'Adour (France). Lab. de Chimie Analytique.
For primary bibliographic entry see Field 5A.
W88-09573

POLAROGRAPHIC DETERMINATION OF LEAD IN DRINKING WATER SAMPLES OF WESTERN U. P. DISTRICTS WITH 3-HYDROXYPYRIDINE-2-THIOL,
M.S. Coll., Saharanpur (India). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W88-09574

PETROLEUM CONTAMINATION OF THE SURFACE MICROLAYER OF THE FOS-SUR-MER GULF (MEDITERRANEAN SEA) (CONTAMINATION PETROLIERE DE LA MICRO-COUCHE DE SURFACE DU GOLFE DE FOS-SUR-MER (MER MEDITERRANEE)),
Centre d'Oceanologie de Marseille (France).
R. Siron, J. F. Rontani, and G. Giusti.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 1+2, p 93-104, January 1987. 4 fig, 3 tab, 27 ref.

Descriptors: *Coastal water, *Hydrocarbons, *Path of pollutants, *Biodegradation, *Surface water, *Seawater, *Oil pollution, *Water pollution, *Mediterranean Sea, *Fos-sur-mer Gulf, Plankton, Bacteria, Chlorophyll, Adenosine triphosphate, Petroleum products, Particulate matter, Dissolved solids.

In a general study on the petroleum contamination of the Fur-sur-mer Gulf (Mediterranean Sea), the surface microlayer was sampled. The first results reported to date in this area, based on a sampling carried out with a rotating polyvinyl chloride drum at 3 stations in May 1985, are presented here. Very high hydrocarbon concentrations were sometimes observed in the surface film, which appears to be more heterogeneous than the underlying water column (0.5-2 m). Water samples were filtered through fiberglass filters (0.5-1 micrometers). Both dissolved and particulate phases were separately extracted and analyzed, providing evidence that suspended particles are the major vector for the accumulation and the transport of petroleum pollutants in these neritic waters. The petroleum origin of 'total hydrocarbons' fractions is confirmed by gas chromatography and high performance liquid chromatography (HPLC)which reveal characteristic features for n-alkalines and polynuclear aromatic hydrocarbons. HPLC analysis of polar (non-hydrocarbons) fractions could indicate their formation from petroleum components. Furthermore, the comparison with the underlying water shows that volatilization and biodegradation are the major processes affecting hydrocarbons distribution in these superficial waters. Biological data (bacteria, chlorophylls, ATP and energetic charge) were simultaneously measured and indicated an important inhibition of phyto- and bacterioneuston on planktonic organisms. (Author's abstract)
W88-09575

ORIGIN OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH) IN RECENT SEDIMENTS FROM THE CONTINENTAL SHELF OF THE 'GOLFE DE GASCOGNE' (ATLANTIC OCEAN) AND IN THE GIRONDE ESTUARY,
Bordeaux-1 Univ., Talence (France). Groupe d'Oceanographie Physicochimique.
P. Garrigues, H. H. Soclo, M. P. Marniesse, and M. Ewald.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 1+2, p 121-131, January 1987. 6 fig, 3 tab, 19 ref.

Descriptors: *Marine sediments, *Sediments, *Hydrocarbons, *Path of pollutants, *Estuaries, *Water pollution sources, Water pollution, Gironde Estuary, Golfe de Gascogne, Atlantic Ocean, Chromatography, Spectroscopy, Spectrofluometry, Continental shelf, Fate of pollutants.

Several aromatic series have been analyzed on sediment extracts by high performance liquid chromatography (HPLC) and by high resolution Shpol'skii spectroscopy. HPLC coupled to a programmable spectrofluorometer as detector has been used for the detection of the sixteen polycyclic aromatic hydrocarbond (PAH) priority pollutants recommended by the US Environmental Protection Agency. A relatively low concentration of PAH's was found compared to those reported in sediments of more polluted European estuaries.

Relative distribution in methylated phenanthrene, chrysene, and pyrene series have been examined by high resolution spectroflurometry in Shpol'skii matrices for the determination of the sources of aromatic matter in the sediments. These complementary studies would provide useful information on the origin of PAH in marine sediments. (Author's abstract)
W88-09576

SOIL CONTAMINATION BY SOME ORGANIC MICROPOLLUTANTS RELATED TO SEWAGE SLUDGE SPREADING,
Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. du Genie de l'Environment.
For primary bibliographic entry see Field 5E.
W88-09577

DETERMINATION OF TRIALKYLLEAD SPECIES IN WATER SAMPLES,
Dortmund Univ. (Germany, F.R.). Inst. of Occupational Health.
For primary bibliographic entry see Field 5A.
W88-09580

TEST SYSTEM FOR THE DETERMINING OF THE FATE OF PESTICIDES IN SURFACE WATER: PROTOCOL AND COMPARISON OF THE PERFORMANCE FOR PARATHION OF ECOCORES AND MICRO ECOSYSTEMS FROM TWO SOURCES,
Institute for Pesticide Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 5A.
W88-09584

EVOLUTION OF HYDROCARBONS AND BACTERIAL ACTIVITY IN MARINE SEDIMENTS CONTAMINATED BY A MIXTURE OF PETROLEUM PRODUCT AND ENHANCER (EVOLUTION DES HYDROCARBURES ET DE L'ACTIVITE BACTERIENNE DANS DES SEDIMENTS MARINS CONTAMINES PAR UN DEVERSEMENT DE PETROLE BRUT ET TRAITE),
Institut Francais de Recherche pour l'Exploitation de la Mer, Brest.
G. Bodennec, J. P. Desmarquest, B. Jensen, and R. Kantin.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 29, No. 3, p 153-178, April 1987. 4 fig, 6 tab, 23 ref.

Descriptors: *Oil spills, *Cleanup operations, *Dispersants, *Hydrocarbons, *Marine sediments, *Biodegradation, *Fate of pollutants, Bacteria, Oil pollution, Dissolved oxygen, Water pollution, Physical properties, Chemical properties, France, Chromatography, Spectrofluorometry, Temperature, Oxidation-reduction potential, Intertidal areas.

The fate of an experimental oil pollution of intertidal sediments in a sheltered beach of North Brittany (France) was investigated over a 16-month period. Chemical treatments were applied to two of the three contaminated plots by pre-mixing oil with dispersant and biodegrading agents, respectively. The physico-chemical and bacteriological characteristics of the polluted areas were followed with the purpose of identifying the limiting parameters for microbial degradation of oil and the effect of treatments. The concentration of hydrocarbons in the oiled sediments did not change significantly during the experimental period. Chromatographic and spectroflurometric data showed that the main evolution of oil concerns the degradation of n-alkanes and the removal of light aromatics. Biodegradation of hydrocarbons occurred at a measurable rate only during the warm seasons (average temperature 18 + or - 2 degrees) causing, after sixteen months, the disappearance of more than 80% of the n-alkanes fraction independent of the pollution sediment level and the chemical treatment of the experimental plots. However, the biodegradation of n-alkanes proceeded at different rates, during the first months, inversely depending on oil content in the collected samples. The main limiting factor is dissolved oxygen as shown by the fact that spilled oil was located at 3-5 cm depth in a poorly oxygenated zone characterized by low redox potential. Nutrients were not a limiting factor probably due to domestic and agricultural inputs. A marked bacterial growth was observed two weeks after the oil spill with a relative increase in hydrocarbon degrading bacteria with respect to total heterotrophs. In the laboratory and field experiments, the same behavior of untreated and chemically treated oil was observed in partially anaerobic sediment. (Author's abstract)
W88-09587

CHARACTERISTIC LEVELS OF CHLORINATED HYDROCARBONS AND TRACE METALS IN FISH FROM COASTAL WATERS OF NORTH AND BALTIC SEA,
Stadtisches Untersuchingsamt Flensburg (Germany, F.R.).
B. Luckas, and U. Harms.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 29, No. 3, p 215-225, April 1987. 2 fig, 4 tab, 13 ref.

Descriptors: *Chlorinated hydrocarbons, *Heavy metals, *Fish, *Water sampling, *Path of pollutants, Contamination, Tissue analysis, Flounders, Water pollution, Coastal waters, North Sea, Baltic Sea, Spatial distribution, Polychlorinated biphenyls, German Bight, DDT, Mercury, Cadmium, Lead, Gas chromatography, Atomic absorption spectroscopy, Weser Estuary, Elbe Estuary.

During investigations on the occurrence and distribution of contaminants in coastal waters of the North Sea and Baltic, organochlorine compounds (such as hexachlorobenzene (HCB), octachlorostyrene (OCS), hexachlorocyclohexane isomers (HCH), dichlorophenyltrichloroethane (p,p'-DDT) and its metabolites) and polychlorinated biphenyls (PCBs) and heavy metals (such as mercury, cadmium and lead) were determined in a selected flatfish species (flounder , Platichthys flesus L.). The sampling network covered the outer estuaries of the rivers Weser and Elbe, the German Bight, the Danish North Sea coast and coastal regions of the south-western Baltic. Organochlorine compounds were determined by high resolution glass capillary gas chromatography with electron capture detector after sample pretreatment and clean up. For the determination of heavy metals, a multi-stage analytical procedure was used in which graphite furnace (for Cd and Pb, respectively), cold vapor (for Hg), atomic absorption spectrometry was combined with pre-instrumental separation and enrichment techniques. Evaluation of the data from the program made significant geographical differences obvious in the levels and pattern with regard to the substances involved. For HCB, OCS, and Hg, a crucial point of contamination within the German Bight was recognized that was apparently influenced to a large extent by the inflow of waters from the Elbe. (Author's abstract)
W88-09588

DETERMINATION OF METHYL- AND ETHYLMERCURY IN NATURAL WATERS AT SUB-NANOGRAM PER LITER USING SCF-ADSORBENT PRECONCENTRATION PROCEDURE,
Swedish Environmental Research Inst., Goeteborg.
For primary bibliographic entry see Field 5A.
W88-09590

MANGANESE IN DRINKING WATER OF THE TOWN OF BEAUCAIRE: ORIGINS AND SOLUTIONS (MANGANESE DANS L'EAU D'ALIMENTATION DE LA VILLE DE BEAUCAIRE: ORIGINES ET SOLUTIONS),
Aix-Marseille-1 Univ. (France). Lab. de Chime Generale.
Y. Claire, B. Dumousseau, P. Jaudon, J. C. Landry, and C. Massiani.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 1, p 37-54, January 1986. 5 fig, 7 tab, 22 ref.

Descriptors: *Water pollution sources, *Manganese, *Drinking water, *France, *Water pollution, *Groundwater pollution, *Groundwater, Bacterial physiology, Iron, Pollutant identification, Bacteria, Domestic water, Aquifers.

Changes in domestic water supply appearance and quality having been found by the inhabitants of Beaucaire, a study was conducted by chemists, hyrdrogeologists and biologists to detect the origin of changes in the appearance and quality of the domestic water. These changes were linked with increasing amounts of iron and manganese. The problem is not specific to this town and can frequently be found in the Saone and Rhone Valleys. The results of the study show that the aquifer in question contains semi-captive groundwater with two sources, the Rhone and calcareous mountains. The low-oxygen waters are enriched by dissolution from gravel with manganese and iron which are preferentially fixed on porous and cracked surface elements. The conditions for manganese liberation are connected with the presence of organic matters, bacteria (capable of reducing manganic compounds) and anaerobiosis. The action of heterotrophic microorganisms using organic matter and consuming oxygen at the groundwater periphery also affects the oxygen level in the water. Thus the central part of the groundwater system is a reducing environment which allows the modification of the bacterial metabolism towards a ferric and manganic reduction process. The result is the transformation of insoluble manganic and ferric compounds into manganous and ferrous compounds which are liberated into the groundwater. (Author's abstract)
W88-09597

STUDY OF THE WEATHERING OF A PETROLEUM PRODUCT SPILLED ON THE OCEAN SURFACE UNDER NATURAL CONDITIONS (ETUDE DU VIEILLISSEMENT D'UN PETROLE BRUT REPANDU A LA SURFACE DE L'EAU DE MER DANS DES CONDITIONS NATURELLES),
Institut Francais du Petrole, Rueil-Malmaison.
J. Ducruex, F. Berthou, and G. Bodennec.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 2, p 85-111, February 1986. 9 fig, 6 tab, 42 ref.

Descriptors: *Degradation, *Emulsifiers, *Oxidation, *Oil spills, *Fate of pollutants, Surfactants, Seawater, Weathering, Oil pollution, Hydrocarbons, Water pollution, Petroleum products.

Photooxidation plays an important role in the weathering process of a petroleum product spilled in the marine environment. Photooxidation generates polar compounds exhibiting a more or less marked surfactant nature. Likewise, photooxidation increases the amount of organic compounds entering the water column by the formation of hydrophilic oxidized compounds. In this study, an Arabian Light crude oil (1 litre) was spread on the surface of unrenewed seawater (320 litres) and was subjected to natural irradiation for 70 days. During this time, five samples of the underlying water as well as five samples of the supernatant oil were taken. The changes in the composition of the different organic compounds present in the two phases were followed. The acidic, basic and neutral compounds were separated by liquid-liquid extraction. The neutral fraction was separated by thin-layer chromatography (T:C) into aliphatic hydrocarbons, aromatic compounds and resins. Each fraction was then analyzed by GC and high-pressure liquid chromatography. At the end of the weathering experiment a high proportion of polar products (acids and resins) was found in the water column with concentrations greater than 8 mg/liter of water, corresponding to an oxidizing degradation of 0.3% of the initial crude oil. The concentrations of hydrocarbons (aliphatic and aromatic) in water were very low (0.4 mg/liter) compared to those of photochemically oxidized products. The oxidation products in the surface hydrocarbon film were characterized by elemental analysis, infrared spectrometry, and liquid-liquid extraction at different pHs. An appreciable increase of polar compounds (acids and resins) with time was revealed, as well as a preferential degradation of aromatic compounds (2 to 3 rings). Moreover, the interfacial

tension (oil/water) decreased very quickly in eight days from 17.5 mN/m to values lower than compounds having an oleophilic nature on the emulsification process (reverse emulsion) of a hydrocarbon spilled at sea. (Author's abstract)
W88-09598

HYDROCARBONS AND AROMATIC HYDROCARBONS IN GROUNDWATER SURROUNDING AN EARTHEN WASTE DISPOSAL PIT FOR PRODUCED WATER IN THE DUNCAN OIL FIELD OF NEW MEXICO,
New Mexico State Univ., Las Cruces. Dept. of Chemistry
G. A. Eiceman, J. T. McConnon, M. Zaman, C. Shuey, and D. Earp.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 2, p 143-162, February 1986. 7 fig, 2 tab, 22 ref.

Descriptors: *Groundwater pollution, *Oil wastes, *Brine disposal, *Hydrocarbons, *Aromatic hydrocarbons, *Duncan Oil Field, *New Mexico, *Path of pollutants, Waste dumps, San Juan River, Benzenes, Water pollution, Waste disposal, Gas chromatography, Mass spectrophotometry.

Samples of groundwater and soil were collected from test pits placed at 25 m intervals on five axes extending from an earthen waste disposal pit for produced water near the San Juan River of northwest New Mexico. Samples were obtained at depths of 1.2 to 1.5 m and were analyzed using GC and GC/MS techniques for purgable hydrocarbons, including benzenes, and for extractable organic compounds. Water samples from test pits down-gradient from the disposal pit contained purgable and extractable hydrocarbons that were similar to contents of the waste disposal pit. In contrast, water samples obtained from test pits up-gradient from the waste pit were free of detectable organic components. Major purgable components in the waste pit and in surrounding groundwater included saturated/unsaturated hydrocarbons and aromatic/alkylated aromatic hydrocarbons. Samples collected 25 m from the waste pit contained concentrations of all compounds greater than in samples taken at 50 m in distance on the same axis. Total concentration of purgabale aromatic hydrocarbons in groundwater from test plots ranged from a high of 200 ppb at 25 m to a low of 12 ppb at 50 m on an axis through the plume center. (Author's abstract)
W88-09599

FATE OF ATRAZINE AND TRIFLURALIN FROM AN INDUSTRIAL WASTE DUMPING AT THE LLOBREGAT RIVER: PRESENCE IN FISH, RAW AND FINISHED WATER,
Instituto de Quimica Bio-Organica, Barcelona (Spain).
For primary bibliographic entry see Field 5A.
W88-09600

EXAMINATION OF THE FATE OF NIGERIAN CRUDE OIL IN SURFACE SEDIMENTS OF THE HUMBER ESTUARY BY GAS CHROMATOGRAPHY-MASS SPECTROMETRY,
Newcastle upon Tyne Univ. (England). Organic Geochemistry Unit.
D. M. Jones, S. J. Rowland, A. G. Douglas, and S. Howells.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 3, p 227-247, March 1986. 6 fig, 3 tab, 34 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Oil pollution, *Estuaries, *Gas chromatography, *Mass spectrometry, Hydrocarbons, Oil spills, Sediments, Biodegradation, Water pollution, England, Humber Estuary, Sediment-water interfaces, Oil.

The hydrocarbon composition of surface sediments at two lithologically different sites in the Humber Estuary (U.K.) has been examined by gas chromatography-mass spectrometry. The sediments were sampled 5, 7 and 12 months after the accidental spillage of 6,000 tons of a Nigerian light crude oil into the estuary from the tanker 'Sivand'. The occurrence of distinctive marker compounds in the Nigerian oil facilitated the identification of residues of the 'Sivand' cargo in the sediments up to 12 months after the spill. Interpretation of chromatograms revealed several other sources of hydrocarbons contributing to the sediments including those from algae, higher plants and fossil fuel combustion products. Field observations and laboratory studies indicated that these compounds were less readily biodegraded in sediments than the oil-derived hydrocarbons. Possible reasons are discussed. (Author's abstract)
W88-09601

DETERMINATION OF BORON BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROSCOPY: II. APPLICATIONS TO SOUTH AFRICAN ENVIRONMENTAL SAMPLES,
Cape Town Univ. (South Africa). Dept. of Analytical Science.
For primary bibliographic entry see Field 5A.
W88-09602

SOLID-PHASE EXTRACTION AND CAPILLARY GAS CHROMATOGRAPHIC DETERMINATION OF TRIAZINE HERBICIDES IN WATER,
Florida Univ., Gainesville. Pesticide Research Lab.
P. C. Bardalaye, and W. B. Wheeler.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 25, No. 1-3, p 105-113, June 1986. 3 fig, 1 tab, 15 ref.

Descriptors: *Pollutant identification, *Triazine pesticides, *Herbicides, *Chromatography, *Gas chromatography, Trace levels, Ametryn, Prometryn, Water pollution, Terbutryn.

A facile and efficient method for the determination of trace quantities of triazine herbicides, terbutryn, prometryn and ametryn in water. The procedure involved preconcentration of water samples by sorption on chromatographic grade silica gel particles with chemically modified surface, being covalently bonded with a nonfunctional C8H17 group. This was followed by solvent desorption with 2-propanol. The determinative step was achieved by capillary gas chromatography on a Supelcowax-10 fused silica column using a nitrogen-phosphorus detector. The limit of detection was 0.1-10 micrograms/liter. (Author's abstract)
W88-09607

MICRO POLLUTANTS IN RED MUD WASTE OF ALUMINUM PLANT,
Madhya Pradesh Pollution Control Board, Raipur (India).
C. B. Patel, V. K. Jain, and G. S. Pandey.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 4, p 269-274, June 1986. 1 fig, 5 tab, 12 ref.

Descriptors: *Trace elements, *Industrial wastes, *Aluminum industry, Atomic absorption spectrophotometry, India, Wastes, Mud, Pollutant identification, Chromium, Manganese, Lead, Copper, Molybdenum, Tin, Aluminum industry.

The production of aluminum has grown steadily in India. The process details of an aluminum plant and the genesis of red mud during the aluminum production have been described. Chemical analysis of a number of red mud samples, collected at different periods, have been carried out. Concentrations of micro pollutants were determined to assess their probable impacts on the soil and water of the adjoining areas. (Author's abstract)
W88-09609

POLYCYCLIC AROMATIC HYDROCARBONS IN SOIL AT GROUNDWATER LEVEL NEAR AN EARTHEN PIT FOR PRODUCED WATER IN THE DUNCAN OIL FIELD,
New Mexico State Univ., Las Cruces. Dept. of Chemistry
B. Davani, K. Lindley, and G. A. Eiceman.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 24, No. 4, p 299-311, June 1986. 4 fig, 1 tab, 12 ref.

Descriptors: *Brine disposal, *Path of pollutants, *Soil contamination, *Groundwater pollution, *Hydrocarbons, Duncan Oil Field, New Mexico, San Juan River, Soil analysis, Trace levels, Waste disposal, Water pollution, Fate of pollutants, Polycyclic aromatic hydrocarbons.

Hydrocarbons, polycyclic aromatic hydrocarbons (PAHs) and alkylated PAHs with two to four rings were found in soil at groundwater level down-gradient from an earthen waste disposal pit for produced water, in the Duncan Oil Field of NW New Mexico. Depth to groundwater was only 1 to 1.5 m in this flood plain of the San Juan River. Complex mixtures of hydrocarbons with carbon numbers from 12 to 30 were detected in solvent extracts of soil samples collected 25 m and 50 m down-gradient from the waste pit. The concentration of total extracted organic mass was as large as 500 ppm at 25 m, but a reduction in concentration of 90-100% was seen for samples at 50 m on the same axes. No similar contamination was found in soil samples located on axes drawn up-gradient from the waste pit. Concentrations for total PAHs in soil at 25 m distance from the waste pit were as large as 4900 ppb an 37 ppb at 50 m on the same axis. Detectable but trace amounts of PAHs in samples up-gradient from the pit may be evidence for secondary dispersion mechanism such as flooding of the region. While groundwater contamination with organic compounds from an earthen waste disposal pit has been demonstrated here, mobility, partition and fate of PAHs in complex mixtures in a soil/groundwater system remain undetermined. (Author's abstract)
W88-09611

DETERMINATION OF THE SPECIATION OF CHROMIUM FROM A BICYCLE FACTORY DISCHARGE,
Dar es Salaam Univ. (Tanzania). Kunduchi Marine Biological Station.
W. M. Kudoja.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 26, No. 1, p 77-81, July 1986. 2 tab, 17 ref.

Descriptors: *Path of pollutants, *Chemical analysis, *Chemical speciation, *Industrial wastes, *Chromium, X-ray fluorescence. Wastewater, Water pollution, Trace metals, Toxicity, Tanzania.

The discharge from a bicycle factory in Dar-es-Salaam was analyzed for dissolved trace metals so as to monitor what was being introduced onto the environment. An X-ray Fluorescence spectrophotometer, with a Si (Li) detector connected to a multichannel analyzer (Canberra 40 series), was used for the analysis. Computation of the peaks and results was done by a Professional Deck 350 computer. The elements contained in the discharge were Ca (596 ppm), Ti (369 ppm), Cr (11ppm), Zn (0.98%) and Sr (73.5 ppm). Further analysis of the speciation of chromium revealed that there was Cr(III) in the amount of 9 ppm and Cr(IV) in the amount of 2 ppm. The level of Cr(IV) is high considering its toxicity. (Author's abstract)
W88-09615

POLYCYCLIC AROMATIC HYDROCARBONS, IN SURFACE SEDIMENTS FROM THE ELIZABETH RIVER SUBESTUARY,
Virginia Inst. of Marine Science, Gloucester Point.
H. Bier, C. Hein, R. J. Huggett, P. Sous, and H. Slone.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 26, No. 2, p 97-113, August 1986. 4 fig, 3 tab, 34 ref. EPA Grant R-806012.

Descriptors: *Path of pollutants, *Water pollution sources, *Estuaries, *Hydrocarbons, *Sediments, *Coal, Correlation coefficient, Sampling, Polycyclic aromatic hydrocarbons, Fate of pollutants, Virginia, Elizabeth River.

The concentration and nature of mainly aromatic and polar organic compounds in surface sediments from the Elizabeth River was assessed in 28 samples, using methodology combining simplicity and reliability so that it could be applied in a quasi routine fashion. The analyses reveal unsubstituted polynuclear aromatic hydrocarbons (PAHs) as major components of these sediments, indicating an origin from high temperature processes. The conspicuous absence of cyclopenta(c,d)pyrene in these samples is characteristic of an origin from coal. Concentrations of PAHs were highest in the Southern branch of the Elizabeth River where the sum of 14 generally abundant pyrogenic PAHs in one sample was 170 ppm and could be traced to two massive spills of wood preservatives. This maximum concentration decreases exponentially towards the mouth of the river with a correlation coefficient of 0.92 and fits a diffusion-advection model for -k/w = 3.5 km. The physical details of the processes dispersing these PAHs are not understood. (Author's abstract)
W88-09616

LINEAR ALKYLBENZENE SULFONATES (LAS) IN SEWAGE SLUDGES, SOILS AND SEDIMENTS: ANALYTICAL DETERMINATION AND ENVIRONMENTAL SAFETY CONSIDERATIONS,
Procter and Gamble/ETC, Strombeek, Bever (Belgium).
For primary bibliographic entry see Field 5A.
W88-09618

VERTICAL TRANSPORT AND ITS EFFECTS ON EPILIMNETIC PHOSPHORUS IN FOUR CALCAREOUS LAKES,
Wisconsin Univ.-Madison. Water Chemistry Lab.
R. E. Stauffer.
Hydrobiologia HYDRB8, Vol. 154, p 87-102, November 16, 1987. 7 fig, 6 tab, 45 ref. EPA Grants 16010-EHR and 5P2-WP-184-04.

Descriptors: *Limnology, *Cycling nutrients, *Chemical properties, *Lakes, *Water circulation, *Epilimnion, *Nutrients, *Phosphorus, Vertical flow, Alkaline water, Wisconsin, Lake Mendota, Entrainment, Eddy diffusion, Wind, Chlorophyll.

The influence of vertical nutrient transport on epilimnetic phosphorus was studied comparatively in four calcareous Wisconsin lakes during 1972. In the two lakes with steep metalimnetic nutrient gradients (Mendota, Delavan), upward fluxes by entrainment and eddy diffusion exceeded all other influxes combined; here epilimnetic total-P concentrations increased during periods of high windpower and thermocline migration, and decreased during comparatively stagnant intervals. In the two lakes lacking upper metalimnetic P gradients (Green, Fish), higher windpower had little or no effect on epilimnetic phosphorus. In each of the four lakes epilimnetic P declined in early summer until a quasi-steady-state was achieved between P influxes and P sedimentation. In Mendota and Delavan steady-state featured higher concentrations of total P, and much higher epilimnetic concentrations of particulate P and chlorophyll, than in Green and Fish Lakes--mainly on account of the high fluxes of molybdate-reactive, biologically-available P through the seasonal thermocline. The flux analysis illustrates why mean lake total P concentration after ice-out is an inconsistent measure for estimating nutrient potential and chlorophyll standing crops during the following summer in stratified lakes. (Author's abstract)
W88-09639

PHYSICO-CHEMICAL ASPECTS OF PARTITIONING OF NON-POLAR HYDROPHOBIC ORGANICS AT THE AIR-WATER INTERFACE,
Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
K. T. Valsaraj.
Chemosphere CMSHAF, Vol. 17, No. 5, p 875-887, 1988. 5 fig, 4 tab, 35 ref.

Descriptors: *Path of pollutants, *Air-water interfaces, *Solubility, *Organic compounds, *Physicochemical properties, Chemical properties, Bonding, Air stripping, Sediment-water interfaces, Hydrophobic compounds.

The binding of highly hydrophobic non-polar organics to low aqueous solubility and vapor pressure at air-water interfaces is discussed. The equilibrium constant for this process is the Henry's constant (H sub x), which is the ratio of the mole fractions of the hydrophobic compounds in the vapor and aqueous phases. The process of binding at the air-water interface results from the hydrophobicity of the molecule. The relevant physical properties for a variety of hydrophobic compounds are presented. The aqueous solubilities of these compounds vary over approximately four orders of magnitude. The aqueous solubility decreases as the molecular size (area and volumes) increases. In general, the vapor pressure also decreases with increasing molecular size for the compounds considered. To illustrate the importance of interfacial binding of hydrophobics, two processes, solvent sublation and diffused bubble air-stripping are described. For non-polar hydrophobic molecules, the mechanisms of the process of transfer of a hydrophobic solute at air-water, sediment-water and octanol-water interfaces can all be unified by adopting basic surface chemical principles. (Friedmann-PTT)
W88-09653

IDENTIFICATION OF ASBESTOS AND GLASS FIBERS IN SEWAGE SLUDGES OF SMALL NEW YORK STATE CITIES,
Environmental Science and Engineering, Inc., Gainesville, FL.
K. J. Patel-Mandlik, C. G. Manos, and D. J. Lisk.
Chemosphere CMSHAF, Vol. 17, No. 5, p 1025-1032, 1988. 2 fig, 2 tab, 31 ref.

Descriptors: *Glass fibers, *Sludge, *Soil contamination, *Pollutant identification, *Asbestos, *Public health, Risks, Municipal wastewater, Population exposure, Light microscopy, Chrysotile, Amosite, Land disposal, New York, Minerals.

Municipal sewage sludges from 15 small New York State cities were analyzed for asbestos and glass fibers using polarized light microscopy and dispersion staining. Asbestos fibers, identified as chrysotile or amosite, were found in nine of the samples and at levels in the range of 1 to 5% by volume in the sludge ash. Glass fibers were also found in ten of the samples. The assessment of possible health risks to humans of asbestos or glass fibers in sewage sludge is, at present, speculative. Since sludge contains nutrient elements essential for plants, and organic matter that can benefit soil structure, it is applied to agricultural and recreational land. Hand-to-mouth contamination by children frequenting sludge-treated soils in such land is of concern. (Friedmann-PTT)
W88-09656

MODELLING THE EFFECT OF ACIDITY ON MERCURY UPTAKE BY WALLEYE IN ACIDIC AND CIRCUMNEUTRAL LAKES,
Michigan Univ., Ann Arbor. School of Natural Resources.
A. L. Jensen.
Environmental Pollution, Vol. 50, No. 4, p 285-294, 1988. 4 fig, 3 tab, 19 ref.

Descriptors: *Path of pollutants, *Acid rain effects, *Bioaccumulation, *Acidity, *Mercury, *Lakes, *Walleye, *Biological magnification, *Acid water, Mathematical models, Accumulation, Fish, Circumneutral lakes, Accumulation, Wisconsin.

An association between acidification of lakes and high mercury concentrations in fishes has been reported. In northern Wisconsin (USA), for example, Walleye (Stizostedion vitreum) in naturally acidic lakes have higher mercury concentrations than walleye in circumneutral lakes. In this study a bioenergetic based model for mercury uptake is applied to identify potential causes of higher mercury concentrations of fishes living in acidic lakes. Application of the model to walleye populations in northern Wisconsin indicates that higher mercury concentrations in acidic lakes are most likely a result of both increased concentrations in the water and increased efficiencies of uptake from water. Higher concentrations in the water would result in higher concentrations in the food. (Author's abstract)
W88-09660

NITRATE IN WATERS FROM SEWAGE-SLUDGE AMENDED LYSIMETERS,
R. L. Jones, and T. D. Hinesly.
Environmental Pollution, Vol. 51, No. 1, p 19-30, 1988. 17 ref, 5 tab.

Descriptors: *Nutrients, *Path of pollutants, *Water pollution sources, *Nitrate, *Lysimeters, *Sludge, *Sludge utilization, *Fertilization, *Agricultural runoff, Tile drainage, Corn, Nitrogen, Surface runoff.

Nitrate nitrogen was measured in runoff and tile-drainage during two years of operation of instrumented, large-scale lysimeters planted to corn (Zea mays L.) and amended with sewage sludge which was applied at rates supplying total N amounting to 2292 kg/ha in 1972 and 3286 kg/ha in 1973. Other lysimeters were amended with inorganic fertilizer at the rate of 336 kg N/ha/year. Annual losses in runoff and tile-drainage from sludge treatments were 0.9 and 5.1, and 371 and 663 kg NO3(-)-N/ha. Losses from lysimeters treated with inorganic fertilizer were 1.1 and 3.3 kg NO3(-)-N/ha/yr in runoff and 31 and 79 kg NO3(-)-N/ha/year in tile-drainage. Given the nitrogen inputs accounted for in the study design, unaccounted-for losses of 1800 to 2400 kg/ha/year were calculated for sludge and 277 kg/ha/year for inorganic fertilizer treatments. For one year there was a 300 kg/ha increase in N in the lysimeters receiving inorganic fertilizer. Median NO3(-)-N concentrations ranged from 8.9 to 14.0 mg/L in runoff from sludge-treated lysimeters and 3.6 to 5.9 mg/L in runoff from lysimeters receiving inorganic fertilizer. In tile-drainage the median NO3(-)-N concentrations were 148 to 223 mg/L and 24 to 44 mg/L for sludge and inorganic fertilizer treatments, respectively. Highest runoff levels occurred in early summer storms, whereas highest tile-drainage concentrations occurred in late winter and early spring. (Author's abstract)
W88-09662

TEMPORAL VARIATION OF METALS IN THE SEAGRASS POSIDONIA AUSTRALIS AND ITS POTENTIAL AS A SENTINEL ACCUMULATOR NEAR A LEAD SMELTER,
Commonwealth Scientific and Industrial Research Organization, Hobart (Australia). Marine Labs.
For primary bibliographic entry see Field 5A.
W88-09667

DISTRIBUTION OF FRESHWATER SNAILS IN THE RIVER NIGER BASIN IN MALI WITH SPECIAL REFERENCE TO THE INTERMEDIATE HOSTS OF SCHISTOSOMES,
Danish Bilharziasis Lab., Charlottenlund.
H. Madsen, G. Coulibaly, and P. Furu.
Hydrobiologia HYDRB8, Vol. 146, No. 1, p 77-88, March 10, 1987. 4 fig, 7 tab, 26 ref.

Descriptors: *Epidemiology, *Stream biota, *Population distribution, *Snails, *Parasites, *Human diseases, *Schistosomiasis, *Trematodes, Infection, Intermediate hosts, Irrigation canals, Lakes, Streams, Biomphalaria, Bulinus, Niger River, Mali.

Snail surveys were carried out in various parts of Mali. All areas surveyed are part of the Niger basin being either affluents or irrigation schemes fed by this river. The snail species present varied greatly between areas. The following potential hosts of schistosomes were recorded: Biomphalaria pfeifferi, Bulinus truncatus, B. globosus, B. umbilicatus, B. forskalii and B. senegalensis. In the large irrigation schemes, i.e. 'Office du Niger' and Baguineda, only B. pfeifferi and B. truncatus appear to be intermediate hosts. Snail distribution appeared to some extent to be focal and high snail densities appeared to be associated with human water contact activities, which apparently create

favorable biotopes for the snails. This is probably due to an alteration of the vegetation and an increase of the trophic status of the site by contamination with food remnants and other debris. The larger irrigation canals or lakes in these schemes play an important role in the transmission of human schistosomes and transmission appears to be very focal in these habitats. Infected snails are almost exclusively found in well-defined human water contact sites (WCS). Local infection rates with schistosomes were often high (i.e. up to 27% in B. pfeifferi). In urban areas such as Bamako, transmission patterns are more variable. In Bamako schistosome-infected B. truncatus were found in the Niger river. A number of smaller semi-permanent or permanent streams are very important transmission sites, and schistosome infections were recorded from B. pfeifferi, B. truncatus and B. globosus. Schistosome infection rates in B. pfeifferi were often up to 30%. In a new lake at Selingue, B. truncatus was found to be widely distributed only about a year and a half after the dam was constructed, and in some sites schistosome infections were recorded. (Author's abstract)
W88-09670

ZN UPTAKE BY CLADOPHORA GLOMERATA,
Vyzkumny Ustav Vodohspodarsky, Prague (Czechoslovakia).
J. Vymazal.
Hydrobiologia HYDRB8, Vol. 148, No. 2, p 97-101, May 20, 1987. 3 fig, 23 ref.

Descriptors: *Path of pollutants, *Zinc, *Algae, *Cladophora, *Bioaccumulation, Accumulation, Adsorption, Hydrogen ion concentration, Light intensity, Population exposure, Heavy metals.

The uptake of zinc by cladophora glomerata at different pH-values, light conditions and exposure periods is reported. These studies indicate that Zn uptake by Cladophora glomerata is pH-dependent in the range studied (5.5-8.5). Uptake increases with rising pH. The greatest amount of Zn taken up over time was during hour 1 followed by hour 2. Results of light/dark experiments indicate that the difference between the mean specific uptake of zinc by Cladophora glomerata under continuous light and continuous dark when pH is kept constant during the exposure period is not significant. A significant increase in the mean specific uptake appears when pH in the medium is not controlled during the exposure under lighted conditions. All of the results support the dominance of adsorptive uptake of zinc by Cladophora. (VerNooy-PTT)
W88-09671

ELEMENTAL COMPOSITION OF THE SUB-AQUATIC LIVERWORT PELLIA ENDIVIIFOLIA (DICKS.) DUM. IN RELATION TO HEAVY METAL CONTAMINATION,
National Inst. for Environmental Studies, Yatabe (Japan).
K. Satake, M. Nishikawa, and K. Shibata.
Hydrobiologia HYDRB8, Vol. 148, No. 2, p 131-136, May 20, 1987. 2 fig, 4 tab, 16 ref.

Descriptors: *Path of pollutants, *Pollutant identification, *Bioindicators, *Metals, *Heavy metals, *Liverworts, *Pellia contamination, Spectrometers, Emission spectroscopy, Inductively-coupled plasma atomic emission spectrometry.

The concentrations of fifteen elements (B, Na, Mg, Al, P, K, Ca, Ti, Mn, Fe, Cu, Zn, Sr, Cd, Pb) in thalli of the sub-aquatic liverwort Pellia endiviifolia (Dicks.) Dum. collected from seven sites in Japan, were analyzed by inductively coupled plasma atomic emission spectrometry (ICP). The average concentration of major essential elements in the thalli was: 49,600 micrograms/gram K, 9140 micrograms/gram Na, 6740 micrograms/gram Ca, 3840 micrograms/gram P, and 3060 micrograms/gram Mg. Thalli of P. endiviifolia from sites polluted by heavy metals (Cu, Zn, Pb) contained high concentrations of these elements (maxima 0.88% Cu, 0.55% Zn and 0.36% Pb in the older thallus), thus demonstrating the potentiality of this liverwort as an indicator for heavy metal contamination. (Author's abstract)
W88-09673

HEAVY METALS IN WATER, SEDIMENTS, FISH AND PLANTS OF RIVER HINDON, U.P., INDIA,
Aligarh Muslim Univ. (India). Environmental Research Lab.
M. Ajmal, Razuiddin, and A. U. Khan.
Hydrobiologia HYDRB8, Vol. 148, No. 2, p 151-157, May 20, 1987. 1 fig, 3 tab, 15 ref.

Descriptors: *Path of pollutants, *Plants, *Heavy metals, *Rivers, *Fluvial sediments, *Water hyacinths, *Water analysis, Fish, Contamination, India.

We analyzed the concentrations of Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn in the water, sediment, fish (Heteropneustes fossilis) and plants (Eicchornia crassipes) of the River Hindon, U.P., India, at seven sampling stations, in the year 1982. Five samples of each kind were collected at the stations, which represented the entire length of the river Hindon from its origin in the hills of Dehradun, U.P. to the point where it merges into the River Yamuna. Considerable variation in concentration between water, sediments, fish and plants were noted. The concentration in the water was in the order Fe > Zn > Cr > Mn > Cu > Pb > Ni > Co > Cd, in the sediments Fe > Mn > Zn > Ni > Cr > Co > Cu > Pb > Cd, in a fish (Heteropneustes fossilis) Fe > Zn > Mn > Pb > Ni > Co > Cu > Cd > Cr, and in a plant (Eicchornia crassipes) Fe > Mn > Zn > Ni > Cu > Cr > Pb > Co > Cd. (Author's abstract)
W88-09674

SUCCESSION IN ZOOPLANKTON AND HYDROPHYTES OF A SEASONAL WATER ON THE WEST COAST OF SOUTH AFRICA,
Department of Nature and Environmental Conservation, Stellenbosch (South Africa).
For primary bibliographic entry see Field 2H.
W88-09678

HEAVY METAL CONTENT OF THE MOSS MNIUM HORNUM GROWING IN THE STEM FLOW AREA OF FAGUS SYLVATICA,
Duesseldorf Univ. (Germany, F.R.). Dept. of Geobotany.
M. Clement, and R. Wittig.
Acta Oecologia AOSPDY, Vol. 8(22), No. 3, p 257-264, 1987. 3 fig, 47 ref.

Descriptors: *Path of pollutants, *Soil contamination, *Heavy metals, *Mosses, *Stemflow, *Fagus sylvatica, *Beech trees, Lead, Cadmium, Zinc, Bioaccumulation, Leaching.

An analysis of heavy metal content of mosses showed the importance of the trunk base area as a habitat of special significance in contrast to the remainder of the stand, with respect to the heavy metals contained in plants. The trunk base area, or skinflow area, called 'Buchenshuerze' (beech apron) by Tuexen, is that part of the forest soil that absorbs the water flowing down from the trunks of trees. The contents of lead in mosses were significantly higher in the trunk base area than they in the center of the stand. No significant differences between the micro habitats could be determined for the elements cadmium and zinc. These findings can be explained by the high input of heavy metals in the trunk base area, by differences in the chemico-physical properties of the three elements under investigation and their varying affinity with mosses. As a result, lead is accumulated, whereas in the case of zinc and cadmium, the processes of accumulation and leaching presumably balance each other. (Vernooy-PTT)
W88-09697

TRACE ELEMENT DISTRIBUTION IN WATERS OF THE NORTHERN CATCHMENT AREA OF LAKE KINNERET, NORTHERN ISRAEL,
Geological Survey of Israel, Jerusalem. Geochemistry Div.
A. Sandler, I. B. Brenner, and L. Halicz.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 35-44, February 1988. 4 fig, 3 tab, 24 ref.

Descriptors: *Trace elements, *Path of pollutants, *Water pollution sources, *Lake Kinneret, Israel, Pollutants, Distribution patterns, Temporal distribution, Water pollution, Sea of Galilee, Jordan River, Fish ponds, Municipal waters.

Waters of the northern watershed of Lake Kinneret, sampled during the period from 1978-1983, were analyzed for their major and trace element contents. The trace element concentrations of the major water sources of the watershed (the Dan and Banias springs) represent background values. After emergence, the waters are subjected to human activity. In crossing the populated and cultivated Hula Basin in man-made canals, the major and trace element contents increased. In comparison to the trace element concentrations, those of the major elements had narrow ranges and small temporal fluctuations. Trace element concentrations varied by 3 orders of magnitude, and temporal variations were large but not necessarily seasonal. Point sources of trace elements were urban effluents, fish pond wastes, and peat soil drainage. The trace element concentrations decreased in the waters of the last segment of the Jordan River. All measured trace elements were below the criteria levels established by regulatory agencies. Several, however, were of the same order of magnitude. Addition of wastes from enhanced recycling, and morphologic modification of the final course of the Jordan River could result in increase in the trace element concentrations in the water. (Author's abstract)
W88-09703

PATHWAY OF TRACE ELEMENTS DURING OIL SHALE COMBUSTION - A CLUE TO THEIR AVAILABILITY FOR LEACHING PROCESSES,
Geological Survey of Israel, Jerusalem.
M. Shirav (Schwartz), and Y. Zimmels.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 55-64, February 1988. 7 fig, 4 tab, 33 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Waste disposal, *Fate of pollutants, *Leaching, *Groundwater pollution, Oil shale, Fluidized bed process, Oil industry, Oil wastes, Groundwater, Model studies, Silicates, Trace elements, Arsenic, Selenium, Cadmium, Pilot plants, Particulate matter.

A model for the pathway of some trace elements during fluidized-bed combustion of Israeli oil shale is suggested, based on both pilot plant and laboratory tests. The model demonstrates the role of carbonate matrix in suppressing the volatilization of trace elements due to fixation of most elements in new-formed silicates. The amount and relative content of the newly synthesized minerals was a function of combustion temperature, grain size, grain composition and the location within the combustor. These factors, combined with the initial residence of the elements in the raw shale, dictated the partition of trace elements within the waste material and their availability for leaching by surface or groundwater out of the wastes which were often used as refill for the mine. Most trace elements which were incorporated into the newly formed, insoluble silicates hardly mobilize into the leachates, whereas the elements which were volatilized at very low temperatures such as As, Se, and Cd, were associated with the anhydrite and exhibited high rates of mobilization. The quality of leachates derived from oil shale combustion wastes could be predicted using the proposed model. (Wood-PTT)
W88-09704

STUDY OF METAL SORPTION/DESORPTION PROCESSES ON COMPETING SEDIMENT COMPONENTS WITH A MULTICHAMBER DEVICE,
Technische Univ. Hamburg-Harburg (Germany, F.R.).

W. Calmano, W. Ahlf, and U. Forstner.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 77-84, February 1988. 7 fig, 16 ref.

Descriptors: *Metals, *Path of pollutants, *Sediments, *Sorption, *Desorption, *Diffusion, *Metal complexes, Fate of pollutants, Ion exchange, Algae, Bentonite, Oxides, Goethite, Clay minerals, Laboratory experiements, Kinetics, Environmental effects, Copper Cadmium, Seawater.

A new multichamber device was developed to study sorption/desorption reactions of metals on different competing sediment components and the influence of environmental factors on these reactions. The system consists of a central chamber connected with six external chambers and separated by membranes with a 0.45 micrometer diameter. The diffusion kinetics of metals between the single chambers were determined. Equilibrium was attained within 24 hours. Algal cell walls (Scenedesmus quadricauda), bentonite, aluminum oxide, manganese oxide, quartz powder, and goethite were used as model sediment components. Determination of metal sorption on the solid phases resulted in a significant enrichment on the algal cell walls, particularly for Cu and Cd. It was concluded that sorption depends not only on ion exchange but also on complexing reactions which lead to relatively stable surface binding. A second series of experiments investigated the effect of seawater on sediment components and dredged mud. Cadmium was remobilized from all solid components, but Cu was not remobilized from algal cell walls and bentonite. The dominant role of organic substrates in the binding of metals such as Cd and Cu is of particular relevance for the transfer of these elements into biological systems. Even relatively small percentages of organic substrates, if involved in metabolic processes, may constitute a major pathway by which metals are transferred within the food chain. (Author's abstract)
W88-09705

NITRATE ENHANCEMENT OF NITRIFICATION DEPTH IN SEDIMENT/WATER MICROCOSMS,
Oxford Univ. (England). Soil Science Lab.
J. G. Cooke, and R. E. White.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 85-94, February 1988. 8 fig, 30 ref.

Descriptors: *Nitrates, *Path of pollutants, *Nitrification, *Sediments, *Sediment-water interfaces, *Streams, Agricultural watersheds, England, Mathematical models, Mathematical equations, Microcosms, Oxidation-reduction potential, Model studies.

Streams draining agricultural catchments in lowland England commonly have high nitrate concentrations. Laboratory microcosms were used to study nitrogen transformations in the sediment from such a stream. Solutions of either 0.5 mmol/cu dm calcium nitrate or calcium chloride (control) were passed once only over the sediment surface. After 5 days incubation, Eh in the nitrate treatment stabilized at approximately 500 mV at 5 mm below the water/sediment interface, and 285 mV at 10 mmn, whereas in the chloride treatment Eh was -200 mV to -250 mV at all measured depths (5 mm and below). Inorganic N measurements of the sediment profiles showed that much more ammonium-N was being lost from the nitrate-treated sediment than the control. It was hypothesized that, when nitrate was present in the streamwater, the combined processes of nitrate diffusion and denitrification progressively consumed organic matter, thereby allowing dissolved oxygen to diffuse further into the sediment. A consequence of these processes would be a greater depth of nitrification and hence more ammonium loss. The plausibility of the hypothesis was evaluated by constructing a deterministic model which simulated the nitrate and ammonium profiles from the processes of diffusion, denitrification, nitrification, and ammonification. Kinetic parameters and diffusion impedance factor were determined from independent experiments. The calibrated model provided reasonable simulations of experimental data obtained from an additional experiment, which also showed that peaks in denitrification and nitrification activity were offset from each other by 2-3 mm, and that they migrated down the profile with increasing incubation time. (Author's abstract)
W88-09706

VARIABILITY OF THE METAL CONTENT OF FLOOD DEPOSITS,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Geography.
H. Leenaers, C. J. Schouten, and M. C. Rang.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 95-106, February 1988. 7 fig, 7 tab, 18 ref.

Descriptors: *Path of pollutants, *Heavy metals, *Fate of pollutants, *Flood deposits, *Floods plains, Flood, River Meuse, River Geul, Industrial wastes, Pollutants, Mine wastes, Metals, Zinc, Lead, Cadmium, Sediments, Mathematical studies, Mathematical equations, Regression analysis, Distribution patterns, The Netherlands.

Fresh flood deposits were sampled in the floodplains of two river systems, the River Meuse, with a catchment area of 33,000 sq km and the River Geul, with a catchment area of 3,000 sq km. As a result of industrial and mining activities, both rivers have a history of severe metal pollution, especially with zinc, lead, and cadmium. The flood deposits of both rivers are heterogeneous mixtures of contaminated bottom sediments (with relatively long residence times in the river) and clean sediments derived from soil erosion on agricultural cropland (with very short residence times). An additional source of sediment is formed by erosion of older, locally highly contaminated streambank deposits. These older sediments are polluted as a result of solid waste disposal containing metalliferous ore and tailings in the sand fraction. This is especially the case in the River Geul, which drains an old zinc and lead mining area. The metal content of the Meuse sediments, however, originates largely from liquid industrial wastes and occurs mainly in the clay fraction. For this reason, the positive correlation between textural composition, organic matter, and heavy metal concentration, which is often reported, was not observed, and normalization of the metal content was not possible. A clear decrease of contamination was noticed along the River Geul; this trend was absent along the River Meuse. An attempt was made to model the longitudinal decay pattern for each of the investigated heavy metals. Regression techniques were used to investigate longitudinal patterns of dispersal along the rivers and geostatistical methods were used to resolve the spatial dependence of dispersal patterns. (Wood-PTT)
W88-09707

SEASONAL VARIATIONS IN THE LOOSELY SORBED PHOSPHORUS FRACTION OF THE SEDIMENT OF A SHALLOW AND HYPEREUTROPHIC LAKE,
Aarhus Univ. (Denmark). Botanical Inst.
M. Sondergaard.
Environmental Geology and Water Sciences EGWSEI, Vol. 11, No. 1, p 115-121, February 1988. 5 fig, 2 tab, 18 ref.

Descriptors: *Phosphorus, *Path of pollutants, *Sediment-water interfaces, *Eutrophic lakes, *Lake sediments, *Eutrophication, Lake Sobygaard, Denmark, Seasonal variation, Hydrogen ion concentration, Interstitial water, Photosynthesis.

On the basis of selective extractions, loosely sorbed phosphorus (ADS-P) has been shown to constitute much of the total phosphorus in the P-rich near-surface sediments of Lake Sobygaard, Denmark. The concentrations of ADS-P are seasonally variable, ranging from 0.2 mg P/g DW in the winter to more than 2 mg P/g DW in the summer. The variations were observed as deep as 10 cm into the sediment but were most pronounced in the upper few centimeters. During the summer, lake and pore water pH levels are very high, and photosynthetic activity causes elevation to pH 10-11 in the lake. Laboratory experiments demonstrated a strong association between ADS-P and high pore water pH. It is likely that Lake Sobygaard represents an extreme example of pH control on sediment/water phosphorus equilibria in which high concentrations of internal ADS-P contribute significantly to the total P load of the lake. (Author's abstract)
W88-09709

EFFECT OF BIOLOGICAL AND PHYSICAL DISTURBANCES ON THE TRANSPORT OF ARSENIC FROM CONTAMINATED ESTUARINE SEDIMENTS,
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
G. F. Riedel, J. G. Sanders, and R. W. Osman.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 25, No. 6, p 693-706, December 1987. 5 fig, 3 tab, 36 ref.

Descriptors: *Water pollution sources, *Bioturbation, *Path of pollutants, *Arsenic, *Estuaries, *Sediments, Model studies, Sediment-water interfaces, Interstitial water, Diffusion, Polychaetes, Aquatic animals, Chesapeake Bay.

From the distribution of dissolved and solid arsenic species in a contaminated estuarine sediment collected from the lower Patuxent River, Chesapeake Bay, and measured rates of flux of the various arsenic species, an empirical model for the cycling of arsenic between sediments and the water column is proposed. The chemical form of arsenic in the sediment was largely determined by the redox state of the sediment. Arsenite was the dominant dissolved and solid species in the deeper reduced sediment, and arsenate was dominant in the oxidized surface layer. Arsenite in the interstitial water diffused toward the surface layer, where it was mostly oxidized to arsenate prior to leaving the sediments. Some arsenate adsorbed to the surface sediments and produced a surface layer enriched in arsenic. Small concentrations of methyl and dimethyl arsenic were produced in the sediments, and these also diffused into the overlying water. Nereis succinea, a burrowing polychaete, affected distribution and flux of arsenic from the sediments by its production of irrigated burrows. These burrows increased both the effective surface area of the sediment and the diffusion of arsenic by a factor of five. When the relative effects of the activities of Nereis succinea and physical resuspension are compared, results indicate that although physical resuspension can produce large pulses of materials from contaminated sediments, continuous biological activity is likely to be more important in the mobilization of contaminants from sediments in many estuarine environments. (Author's abstract)
W88-09716

SEASONAL PATTERNS AND WATER QUALITY IN KING TALAL RESERVOIR, JORDAN,
Jordan Univ., Amman. Dept. of Biological Sciences.
F. Hashwa, and G. R. Marzolf.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 3, p 387-397, September 1987. 5 fig, 3 tab, 11 ref.

Descriptors: *Path of pollutants, *Limnology, *Water quality, *Seasonal variation, *King Talal Reservoir, Eutrophication, Wastewater, Nutrients, Phosphorus, Nitrogen, Chlorophyll a, Temperature, Jordan, Zarqa River.

The King Talal Reservoir, a recent (1978) impoundment of the Zarqa River, is a warm monomictic and eutrophic water body. The surface temperature in summer is 25 C while a homogeneous temperature minimum of 12 C was recorded during the December turnover of 1981. The thermocline was about 8 m while the hypolimnion was anoxic during the whole thermally stratified period from March to November. The reservoir, 60 m high at dam, has a mean depth of 21.5 m at the full capacity of 56 000 000 cu m. The reservoirs's limnological characteristics are dominated by the hydrologic regime of the Zarqa River which is the sole exporter of nutrients and waste effluents from

the large semi-arid but densely populated catchment area. The highest concentrations of phosphorus and nitrogen enter the reservoir with high flows during flood events in winter. Maximal chlorophyll-a concentrations exceeded 1500 micrograms/l at the surface during April 1982. (Author's abstract)
W88-09755

TROUT FARMS CAUSING DISTURBANCE IN THE NATURAL STREAM CONTINUUM (STOERUNG DES NATUERLICHEN LAENGSGRADIENTEN EINES BERGBACHES DURCH FORELLENTEICHANLAGEN),
Gesamthochschule Essen (Germany, F.R.). Lehrstuhl fuer Hydrobiologie.
For primary bibliographic entry see Field 8I.
W88-09756

ECOLOGY OF JACARE PEPIRA RIVER BASIN: INFLUENCE OF SOIL AND WATER USE AND EFFLUENT DISCHARGE ON WATER QUALITY (SAO PAULO STATE, BRAZIL) (ECOLOGIA DA BACIA DO RIO JACARE PEPIRA: INFLUENCIA DO USO DO SOLO, DA AGUA E DA DESCARGA DE EFLUENTES SOBRE A QUALIDADE DA AGUA (SAO PAULO, BRASIL)),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 5C.
W88-09777

AUTODEPURATION OF RIO GRANDE RESERVOIR (RIACHO GRANDE SP, BRAZIL) MAJOR IONS AND CHLOROPHYLL A (AUTODEPURACAO DA REPRESA RIO GRANDE (RIACHO GRANDE SP, BRASIL) IONS DOMINANTES E CLOROFILA A),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
M. Takino, and M. H. Maier.
Boletim do Instituto de Pesca, Vol. 13, No. 1, p 179-184, June 1986. 3 tab, 25 ref.

Descriptors: *Reservoirs, *Self-purification, *Ions, *Chlorophyll a, *Chemical properties, *Fate of pollutants, Salinity, Algicides, Pesticides, Sodium, Calcium, Magnesium, Potassium, Chlorine, Carbonates, Sulfates, Rio Grande Reservoir, Brazil.

This paper continues the research on the depuration process of Rio Grande Reservoir, trying to determine the physiographic and anthropic influences on this process. The results of monthly samplings of the water column (October 1982 to September 1983) at 3 sampling stations showed the cationic and anionic proportions Na> Ca> Mg> K and Cl> HCO3> SO4 (meq/l), which were as found in 1979. Changes in the cation concentrations led to small changes in the monovalent/divalent, divalent/divalent and monovalent/monovalent ratios. The chlorophyll a content showed a considerable reduction; the median (4.91 microgram/l) was approximately 10 times lower than that obtained in 1979. The median values for each station were quite similar. The reduction of the chlorophyll a content could be a result of the effect of intensive treatment of algicides that the reservoir periodically receives. The salinity suffered a dilution along the major axis of the reservoir compared to previous studies (1979). (Author's abstract)
W88-09778

USE OF MACROBENTHOS AS INDICATORS OF THE WATER QUALITY IN THE RIVERS OF PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP (ORGANISMOS BENTONICOS COMO INDICADORES DA QUALIDADE DA AGUA DE RIOS DO PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
L. T. Schroeder-Araujo, and M. N. Cipolli.
Boletim do Instituto de Pesca, Vol. 13, No. 2, p 77-83, December 1986. 2 fig, 5 tab, 12 ref.

Descriptors: *Bioindicators, *Bioindicators, *Benthos, *Path of pollutants, *Water quality, *Environmental effects, *Aquatic animals, *Benthic fauna, *Limnology, Parque Estadual do Campos do Jordao, Benthic environment, Aquatic insects, Fish, Species diversity, Brazil.

The benthic community of the four rivers of Parque Estadual de Campos do Jordao was studied with the purpose of assessing the use of the macrobenthic organisms as indicators of the water quality. The rivers were divided into five sections; monthly collections were made from March 1984 to February 1985. A comparison of the five sections was based on the physical and chemical characteristics of the water and the environmental indicators such as Diptera (Chironomus, Tanytarsini, Orthocladiinae), Trichoptera and Ephemeroptera, the index of diversity of organisms and the percentage of similarity using the different groups of Diptera (particularly the Chironomidae). It is concluded that the Canhambora and Casquilho streams are the least polluted environments and that the Sapucai-Guacu River is very different from the others and is the least favorable for fish life. (See also W88-09779) (Author's abstract)
W88-09780

APPLYING THE USGS MASS-TRANSPORT MODEL (MOC) TO REMEDIAL ACTIONS BY RECOVERY WELLS,
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
For primary bibliographic entry see Field 2F.
W88-09781

HYDROCHEMICAL CHARACTERIZATION OF BRINES AND IDENTIFICATION OF BRINE CONTAMINATION IN AQUIFERS,
Kent State Univ., OH. Dept. of Geology.
For primary bibliographic entry see Field 5A.
W88-09785

INFLUENCE OF OUTLYING OBSERVATIONS ON SELECTED ESTIMATES OF PARAMETERS OF DISTRIBUTIONS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 7C.
W88-09786

COLLECTION MANIFOLD FOR MULTILEVEL GROUND-WATER SAMPLING DEVICES,
British Geological Survey, Keyworth (England). Fluid Processes Research Group.
For primary bibliographic entry see Field 7B.
W88-09788

MEASUREMENT OF BACTERIAL GROWTH RATES IN SUBSURFACE SEDIMENTS USING THE INCORPORATION OF TRITIATED THYMIDINE INTO DNA,
Dayton Univ., OH. Dept. of Biology.
For primary bibliographic entry see Field 7B.
W88-09790

INVESTIGATIONS INTO THE NUMBER OF RESPIRING BACTERIA IN GROUNDWATER FROM SANDY AND GRAVELLY DEPOSITS,
Max-Planck-Inst. fuer Limnologie, Schlitz (Germany, F.R.). Limnologische Flussstation.
J. Marxsen.
Microbial Ecology MCBEBU, Vol. 16, No. 1, p 65-72, 1988. 4 fig, 3 tab, 12 ref.

Descriptors: *Groundwater pollution, *Bacterial physiology, *Bacteria, *Soil bacteria, Sand, Gravel, Dissolved solids, Biomass, Respiration, Microscopy, Oxygen, Water pollution.

Samples were collected from organically polluted and unpolluted groundwater of sandy and gravelly deposits. After filtration onto polycarbonate filters (0.2 micrometer pore size) the number of respiring bacteria was recorded by microscopically counting cells containing red INT-formazan spots, which characterize respiring bacteria. The total number of bacteria was simultaneously recorded by epifluorescence microscopy after staining with acridine orange. The number of respiring bacteria in the groundwater samples (55000-490,000/cu cm) is within the range of values for other aquatic biotopes, but as the total number of bacteria in groundwater was unusually higher, the proportion of respiring groundwater bacteria (0.66-7.4%) was lower. Mainly larger bacteria, rods, and bacteria on particles could be identified as being active, whereas hardly any respiring activity could be detected among small cocci and free intestinal bacteria. If the supply of dissolved organic matter (DOM) is adequate, the biomass of respiring bacteria correlates well with oxygen concentration, but there is no direct correlation between DOM concentration in groundwater and active bacterial biomass. No relationship observed between the biomass of total and respiring bacteria, or between the quantity of respiring bacteria and heterotrophic bacterial activity. (Author's abstract)
W88-09794

RECORD OF HEAVY METAL POLLUTION IN SEDIMENT FROM THE SETO INLAND SEA,
Government Industrial Research Inst., Chugoku, Kure (Japan).
A. Hoshika, and T. Shiozawa.
Journal of Earth Science Nagoya University JEASAD, Vol. 35, No. 2, p 203-225, December 1987. 16 fig, 2 tab, 32 ref.

Descriptors: *Water pollution, *Heavy metals, *Path of pollutants, Copper, Zinc, Nickel, Chromium, Manganese, Iron, Lead radioisotopes, Particle size, Spatial distribution, Nutrients, Marine sediments, Seto Islands, Japan.

To monitor the chemical environment of the Seto Inland Sea, which is the largest semi-closed coastal sea of Japan, (1) horizontal distribution of grain size, nutrients and heavy metals of the surface sediments were examined, (2) the behaviors of heavy metals concerning pollution were studied through the selective chemical leaching technique and the lead-210 dating method of surface and core sediments, and (3) mass balances of copper and zinc were studied by applying a simple box model. Increase in heavy metal contents of core sediments already started as early as the 1800s in Hiuchi-Nada and Osaka Bay of the Seto Inland Sea, and is considered to be due to human activities. The heavy metal pollution in the 2 areas is very serious; enrichment ratios (total content/background content) are 4 for zinc in Osaka Bay and 3 for copper in Hiuchi-Nada. In 1980, total sedimentary loads of copper and zinc over the whole area of the Seto Inland Sea were estimated to be 630 and 3,500 ton/yr, respectively. The sedimentary loads without (natural or background) and with human activities were estimated separately to be 320 and 310 ton/yr for copper and 1,800 and 1,700 ton/yr for zinc, respectively. Total inputs of copper and zinc into the Seto Inland Sea were estimated to be 870 and 4,250 ton/yr, respectively, and about a half of the inputs is due to human activities. Seventy percent of copper input and 80% for zinc input are accumulated into sediments. Mean residence times of copper and zinc are calculated to be about 0.3 and 0.2 years, respectively. Since these values are relatively small compared to the mean residence time of the sea water (0.9 years), copper and zinc supplied to the Seto Inland Sea are considered to be accumulated rapidly into sediments. (Author's abstract)
W88-09798

PARTITIONING OF MANGANESE, IRON, ARSENIC, CADMIUM, LEAD, COPPER, ZINC, COBALT AND NICKEL IN SEDIMENTS FROM LAKE BIWA,
Okayama Univ., Kurashiki (Japan). Inst. for Agricultural and Biological Sciences.
S. Nakashima.
Journal of Earth Science Nagoya University JEASAD, Vol. 35, No. 2, p 365-380, December 1987. 12 fig, 23 ref.

Descriptors: *Water pollution, *Heavy metals, *Path of pollutants, *Lakes, *Bottom sediments, Manganese, Iron, Arsenic, Cadmium, Lead, Copper, Vertical distribution, Zinc, Cobalt, Nickel,

Sulfides, Silicates, Iron oxides, Manganese oxides, Lake Biwa, Japan.

In order to investigate the mechanism of metal accumulation in the bottom sediment of Lake Biwa, 2 sediment cores (22 cm long) from the central basin (about 90 m in water depth) of the northern part of the lake were analyzed for 9 heavy metals. Partitioning of these elements into mineral and organic fractions was determined with a selective chemical leaching technique for the core samples. The total heavy metals contents of the core samples are classified into 2 groups on the basis of vertical distributions: (1) Manganese, arsenic, and to a lesser degree cadmium, lead, copper and zinc are concentrated in the upper 2 cm layer of the core. (2) Iron, cobalt and nickel contents exhibit no vertical gradient. Manganese and cadmium are enriched in both the exchangeable and the hydrous Fe/Mn oxide fractions in the upper 2 cm layer of the core samples. Arsenic, lead, copper and zinc are concentrated in the hydrous Fe/Mn oxide fraction in the surface layer of the sediments. The heavy metal contents of sulfide, organic and silicate fractions are relatively constant regardless of depth in the core. The remarkable enrichment of manganese and arsenic in the oxidized upper layer of the sediments is assumed to be mainly due to upward migration of dissolved manganese and arsenic from the deeper and reduced layers and due to reprecipitation in the thin, oxidized surface layer. The high cadmium, lead, copper and zinc contents of the upper 2 cm layers are presumably due to upward migration in addition to supply through human activities. These results suggest hydrous Fe/Mn oxides play an important role in the removal and surface enrichment of heavy metals in the sediments of Lake Biwa. (Author's abstract)
W88-09801

ALKALINITY AND MAJOR ION BUDGETS FOR A MASSACHUSETTS RESERVOIR AND WATERSHED,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W88-09844

EFFECT OF TIDAL ACTION ON THE DISTRIBUTION OF NUTRIENTS AND HEAVY METALS IN FLAT SEDIMENTS OF THE ELBE ESTUARY, (DER EINFLUSS DER GEZEITEN AUF DIE VERTEILING VON NAHRSTOFFEN UND SCHWERMETALLEN IN WATTSEDIMENTEN DES ELBE-AESTUARS),
Hamburg Univ. (Germany, F.R.). Inst. fuer Hydrobiologie und Fischereiwissenschaft.
M. Kerner, H. Kausch, and M. Kersten.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 75, No. 1, p 118-131, October 1986. 6 fig, 24 ref.

Descriptors: *Elbe Estuary, *Tidal effects, *Path of pollutants, *Heavy metals, *Cycling nutrients, Solute transport, Coastal waters, Estuaries, Cadmium, Nutrients, Aquatic plants.

An investigation on plant nutrients and heavy metals in the interstitial water of freshwater tidal flat sediments along the Elbe was carried out by analyzing 2 cm subsamples from sediment cores 30 cm long. The hydrological dynamics of a high tidal flat to produce a distinct biogeochemical depth zonation in the sediment, in which aerobic microbiological respiratory processes continue even in the deeper layers. This tidally mediated 'oxidative pumping' results in a subsequent withdrawal of assimilated inorganic N and a remobilization of Cd from highly contaminated sediments. (Author's abstract)
W88-09876

IRON PHOTOREDUCTION AND OXIDATION IN AN ACIDIC MOUNTAIN STREAM,
Geological Survey, Denver, CO. Water Resources Div.
D. M. McKnight, B. A. Kimball, and K. E. Bencala.
Science SCIEAS, Vol. 240, No. 4852, p 637-640, April 29, 1988. 2 fig, 2 tab, 20 ref.

Descriptors: *Path of pollutants, *Iron, *Photoreduction, *Acid streams, *Acid mine drainage, *Iron oxides, Variability, Oxidation, Chemical reduction, Water sampling, Tracers.

In a small mountain stream in Colorado that receives acidic mine drainage, photoreduction of ferric iron results in a well-defined increase in dissolved ferrous iron during the day. To quantify this process, an instream injection of a conservative tracer was used to measure discharge at the time that each sample was collected. Daytime production of ferrous iron by photoreduction was almost four times as great as nighttime oxidation of ferrous iron. The photoreduction process probably involves dissolved or colloidal ferric iron species and limited interaction with organic species because concentrations of organic carbon are low in this stream. (Author's abstract)
W88-09902

ACCUMULATION OF MICROELEMENTS BY PLANTS ON WATERSHEDS IN THE PERMAFROST-TAIGA ZONE,
Institut Eksperimental'noi Meteorologii, Obninsk (USSR).
K. P. Makhon'ko, Y. K. Vertinskii, and T. G. Raspopova.
Soviet Journal of Ecology SJECAH, Vol. 18, No. 4, p 200-204, March 1988. 2 tab, 2 fig, 10 ref. Translated from Ekologiya, No. 4, p 19-24, July-August 1987.

Descriptors: *Path of pollutants, *Trace metals, Permafrost, *Heavy metals, *Coniferous forests, *Bioaccumulation, Plant tissues, Baseline studies, Metals, Distribution graphs, Lead, Cadmium, Mercury, Manganese, Nickel, Copper, Zinc, Siberia, USSR.

The background concentrations of Pb, Cd, Hg, Mn, Ni, Cu, and Zn were determined in individual plant species, and the coefficients of accumulation K of these microelements by plants and the repeatability of K were found in the biogeocenose of watersheds in the permafrost-taiga zone. The area studied was in Siberia near the central region of the Baikal-Amur Railroad. It was shown that for plants the distribution function in terms of the magnitude of K is bimodal for nickel and unimodal for the remaining metals; moreover, in some instances t is described by logarithmically normal or normal laws. The features of the form of the curve of the distribution function characterize the ability of the plant cover to accumulate metals and are due not only to the selectivity of the absorption of metals by individual plant species, but also to the frequency of encounter of these species in the given biogeocenose. The data obtained may serve as a basis for the further accumulation of information on the background content of metals in the vegetation of the region under consideration prior to its industrial exploitation. (Author's abstract)
W88-09903

MOVEMENT OF METHYL PARATHION, LINDANE AND ATRAZINE THROUGH LYSIMETERS IN FIELD CONDITIONS,
Ioannina Univ. (Greece). Dept. of Chemistry.
T. A. Albanis, P. J. Pomonis, and A. T. Sdoukos.
Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 1, p 35-45, 1988. 4 fig, 5 tab, 18 ref.

Descriptors: *Path of pollutants, *Parathion, *Lindane, *Atrazine, *Lysimeters, *Leaching, *Soil water, Rainfall, Pesticides, Soil types, Greece.

The movement of the pesticides methyl parathion, lindane and atrazine due to leaching by rainfall was studied in lysimeters containing different types of soil from the Ioannina area of Greece. For a period between October 1985 to June 1986 the amount of pesticides was analyzed in water samples from rainfall concentrated after filtration through the soils to a depth of 100 cm. The total percentages of the initial amounts of each pesticide transported in this way were 0.15-0.26% for methyl parathion, 0.15-0.19% for lindane and 0.54-0.66% for atrazine. The results of these experiments indicate that the transport of methyl parathion, lindane and atrazine might be significant in underground water supplies especially if the amount of these pesticides used is large. The problem is presented more seriously by atrazine which is a base and an easily ionizable compound, and also is very easily transported (eluted) by moving waters. The amounts of methyl parathion and lindane transported are also significant but methyl parathion is rapidly degraded while lindane is used in rather restricted amounts. (Author's abstract)
W88-09904

ESTIMATION OF ENVIRONMENTAL FATE OF INDUSTRIAL CHEMICALS,
Mitsubishi-Kasei Inst. of Toxicological and Environmental Sciences, Yokohama (Japan).
K. Yoshida, T. Shigeoka, and F. Yamauchi.
Toxicological and Environmental Chemistry TXECBP, Vol. 17, No. 1, p 69-85, 1988. 5 fig, 7 tab, 15 ref.

Descriptors: *Industrial wastes, *Fate of pollutants, *Mathematical models, *Chemical wastes, Mathematical analysis, Chloroform, Chlorinated hydrocarbons, Benzenes, Aromatic compounds, Biodegradation, Fish, Environmental effects.

A mathematical model, Multi-Phase Non-Steady State Equilibrium Model version 1.3 (MNSEM1.3) was applied to estimate the generic environmental fate of five industrial chemicals which are produced in large quantities (chloroform, aniline, chlorobenzene, nitrobenzene, and naphthalene). Version 1.3 considers non-diffusive transfer processes (rainfall, runoff, setting) in addition to diffusive interphase transfer processes. Furthermore, this version calculates a clearance time (which is defined as the time required to reduce 90% of the steady state chemical mass) in case of termination of loading. Estimated concentrations in air, water, sediment or fish were within a factor of 6 of averages of concentrations measured at several points in Japan. Reasonable agreement with measured values suggests that estimated fate profiles are adequately representative of the generic environmental fate of the five chemicals in Japan. (Author's abstract)
W88-09905

OCCURRENCE, DISTRIBUTION AND AVAILABILITY OF PAH IN SURFACE WATERS AND SEDIMENTS,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
W. A. Bruggeman, and W. G. H. Van der Naald.
Toxicological and Environmental Chemistry TXECBP, Vol. 16, No. 4, p 241-243, 1988. 1 fig.

Descriptors: *Hydrocarbons, *Aromatic compounds, *Surface waters, *Path of pollutants, *Bottom sediments, *Netherlands, Spatial distribution, Regional analysis, Sediments.

A distinction between low-molecular weight (small) and high-molecular weight (large) polycyclic aromatic hydrocarbons (PAHs) facilitates the description of occurrence, behavior and potential effects of PAHs in surface waters; the borderline is at a molecular weight of about 225. The large PAHs are slightly volatile and very hydrophobic. Their occurrence is therefore mainly confined to suspended particulate matter and sediment. The small PAHs are present predominantly in their dissolved form. PAH concentrations in the large rivers in the Netherlands are relatively high as a result of transboundary fluxes. Low concentrations were found for the North Sea and more isolated inland waters. (VerNooy-PTT)
W88-09906

BIOAVAILABILITY OF CHEMICALS IN WASTE PRODUCTS AND IN POLLUTED SOIL,
MICON Environmental Consultants, Vught (Netherlands).
For primary bibliographic entry see Field 5C.
W88-09907

SEXUAL DIFFERENCES IN ACCUMULATION OF MERCURY IN FOUR SPECIES OF CENTRARCHID FISHES,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
P. F. Nicoletto, and A. C. Hendricks.
Canadian Journal of Zoology CJZOAG, Vol. 66, No. 4, p 944-949, April 1988. 2 fig, 4 tab, 19 ref.

Descriptors: *Path of pollutants, *Bioaccumulation, *Sex differences, *Mercury, *Fish, Mature growth stage, Muscle, Tissue analysis, Bass, Bluegills, Pumpkinseed fish, Shenandoah River, Fate of pollutants, Virginia.

A 3-year study of fish from the South River, the South Fork of the Shenandoah River, and the Shenandoah River in Virginia revealed significant differences in the muscle mercury content of males and females. Female rock bass, Ambloplites rupestris, redbreast sunfish, Lepomis auritus, pumpkinseed, Lepomis gibbosus, and bluegill, Lepomis macrochirus contained higher levels of mercury than the males of each species. An analysis of these species indicated that sex-related differences in mercury levels were not due to differences in body size but may have been related to the onset of reproduction. For example, mercury levels in 1-year-old male and female redbreast sunfish were not significantly different: females averaged 0.66 microgram Hg/g and males averaged 0.63 micrograms Hg/g. However, at 2 years of age, when redbreast sunfish first reproduce, females contained significantly more mercury than males: females averaged 0.84 micrograms Hg/g and males averaged 0.60 micrograms Hg/g. Analysis of the other species yielded similar results. (Author's abstract)
W88-09910

PREDICTION OF TIME VARIATION IN WATER AND CHLORIDE PROFILES IN A SOIL SUBJECT TO CROPPING AND ANNUAL APPLICATION OF SEWAGE SLUDGE,
National Inst. for Environmental Studies, Tsukuba (Japan). Systems Analysis and Planning Div.
For primary bibliographic entry see Field 5E.
W88-09911

SIMULATION OF RUNOFF AND NITRATE LEACHING FROM AN AGRICULTURAL DISTRICT IN SWEDEN,
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
P.-E. Jansson, and by R. Andersson.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 33-47, May 1988. 6 fig, 2 tab, 20 ref.

Descriptors: *Agricultural runoff, *Leaching, *Nitrates, *Runoff, Fertilizers, Agricultural chemicals, Solute transport, Leachates, Watersheds, Model studies, Mathematical studies, Hydrology, Geohydrology, Prediction, Crop yield, Mineralization, Growth, Sweden, Simulation.

A twenty-year series of runoff and nitrogen leaching measurements from a cereal-dominated agricultural watershed in southern Sweden indicated a trend towards increased leaching. To investigate causal factors associated with the trend, two simulation models were used. Water and heat conditions were simulated with a physically based model. Simulated values agreed well with observed water flows, and no significant change in water balance as a result of alterations in land use were detected. Based on the simulated soil climate and data on land use, soil nitrogen dynamics were simulated with a nitrogen model. Model predictions were tested against leaching measurements. Alternative assumptions of 'fast' or 'slow' turnover of nitrogen in crop residues were tested. Model simulations of leaching agreed best with measured trends when a fast turnover rate of crop residues was assumed (i.e., < 50% of crop residue N was stabilized in humus). It was not possible to simulate the measured trend towards increased leaching if the proportion of crop residues incorporated into the humus pool was increased (i.e., 'slow turnover'). Only a minor fraction of the applied fertilizer was lost directly to the stream, but substantial losses occurred because of mineralization of organic material. (Author's abstract)
W88-09913

SESTON AND DISSOLVED ORGANIC CARBON TRANSPORT DURING STORM FLOWS IN A NATURAL AND A DISTURBED COASTAL PLAIN STREAM,
Savannah River Ecology Lab., Aiken, SC.
L. G. Leff, and J. V. McArthur.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 271-277, June 1988. 2 tab, 28 ref. DOE Contract DE-AC09-76SR00-819.

Descriptors: *Deforestation, *Storms, *Seston, *Organic carbon, Decomposing organic matter, Temporal distribution, Path of pollutants, Solute transport, Macroinvertebrates, Population dynamics, Streams, Thermal pollution.

Transport of seston and dissolved organic carbon (DOC) was examined during storm flows in a disturbed and a natural blackwater, coastal plain stream. The disturbed stream had fewer retentive devices due to destruction of riparian vegetation by thermal effluents. Concentrations of seston declined linearly in both streams as the storms progressed. Particulate organic carbon concentrations were higher in the natural streams. However, at baseflow the relationship was reversed. DOC did not change during storm flows. The retentive devices in the natural stream were ineffective at reducing transport during storm flows. The relationship between storm flows, retentiveness, and carbon transport may affect the diversity and density of invertebrates. (Author's abstract)
W88-09925

ASPECTS OF BIOCHEMICAL SULPHUR CONVERSIONS IN SEDIMENTS OF A SHALLOW SOFT WATER LAKE,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
J. A. A. R. Schuurkes, A. J. Kempers, and C. J. Kok.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 369-381, June 1988. 3 fig, 4 tab, 37 ref.

Descriptors: *Acid rain, *Acidic water, *Path of pollutants, *Lakes, *Nitrates, *Sulfates, *Sediments, Sulfur compounds, Limnology, Water chemistry, Cycling nutrients, Decomposing organic matter, Organic carbon, Chemical analysis, Sulfides, Iron, Alkalinity.

Aspects of sulfur conversions in mineral sandy sediments from a shallow soft water lake were examined in vitro with addition of sodium sulfate. Quantitative aspects of sulfate reduction in the sediment were studied in relation to the sulfate content, nitrate and the amount of organic matter. Implications are given that the rate of sulfate reduction is limited by organic matter at in situ sulfate concentrations. The presence of significant amounts of nitrate reduced the sulfate reduction considerably. Sulfate reduction caused alkalinization of the ambient medium, supporting the consumption of 2 mol H(+) ions per mol sulfate converted. The amount of iron present in the sediment was able to fix the major part of the sulfide produced by sulfate reduction. In the presence of oxygen, sulfides were rapidly oxidized and acidified the incubation medium to pH 5.6. (Author's abstract)
W88-09934

MERCURY IN FISH AND INVERTEBRATES IN LAKE MJOSA (KVIKKSOLV I FISK OG EVERTEBRATER I MJOSA),
Kongelige Selskap for Norges Vel, Skjeten.
O. T. Sandlund, G. Kjellberg, and G. Norheim.
Fauna, Vol. 40, No. 1, p 10-15, 1987. 2 fig, 4 tab, 23 ref.

Descriptors: *Fish, *Lake Mjosa, *Mercury, *Zooplankton, *Path of pollutants, *Macroinvertebrates, Tissue analysis, Lakes, Chemical analysis, Water pollution sources, Industrial wastewater, Food chains, Food habits, Heavy metals, Statistical methods, Fish, Norway, Aquatic habitats, Crustaceans, Fish behavior.

Mercury was determined in muscle tissue from six species of fish caught in three sampling areas in Lake Mjosa (Norway), 1979-80. The species investigated were vendace, smelt, perch, burbot, pike and brown trout. In addition, specimens of crustacean zooplankton, Mysis relicta, Pallasea quadrispinosa and Gammaracanthus loricatus were analyzed. During the period 1960 to 1970 about 2.5 tons of mercury were released into Lake Mjosa from the pulp and paper industries near Lillehammer. Among the invertebrates analyzed, the highest mercury levels were detected in the oldest specimens of Gammaracanthus loricatus. In four of the fish species a significant, positive correlation between age and mercury level was observed. There seems to be a close relationship between the mercury level in the main food items and the mercury level in the fish. The increase in mercury level in older fish seems to indicate that their choice of habitat is of importance. Burbot and perch that live near the bottom show the largest increase in mercury level, as indicated by the regression coefficients. The brown trout lives in river habitats the first 2-5 years of life before they migrate into the lake. This may explain the lack of correlation between mercury level and age in this species. (Author's abstract)
W88-09947

HYGIENIC QUALITY OF WATER AND ITS RELATIONSHIP WITH MILK BACTERIAL CONTENT, (CALIDAD HIGIENICA DEL AGUA Y SU RELACION CON EL CONTENIDO MICROBIANO DE LA LECHE),
Chile Univ., Santiago. Facultad de Ciecias Veterinarias.
H. Aguero, C. Pedraza, and S. Godoy.
Agricultura Technica (Chile), Vol. 47, No. 2, p 136-141, April-June 1987. 2 tab, 14 ref.

Descriptors: *Dairies, *Disinfection, *Water quality, *Water pollution effects, *Path of pollutants, *Coliforms, Statistical methods, Mathematical studies, Public health, Chile.

In 10 dairy farms of the Region Metroplitana (Chile), samples of the water used to sanitize the milking equipment were collected at the same time with milk samples, that were kept for 48 hr at 4 C, simulating the process that takes place in a cooling tank. Methylene blue reduction test (MBRT), total bacterial (TBC), psychrotrophica (PC) and coliforms (CC) counts were determined in the milk samples; the same analysis were practiced in the water samples, with exception of MBRT. Correlation analysis between bacteriological variables in milk and water samples were made; also, milk samples were stratified, according to the water sanitary quality levels (good and poor), performing a t test for each of the variables. Average water counts were 13,834/ml (TBC), 1,816/ml (PC) and 5,239/100 ml (CC); using different standards, the levels of hygienic acceptable samples fluctuated between 16.6 - 86.7, 36.7 - 80.0, and 0 - 50% for TBC, PC and CC, respectively. A significant relationship was obtained only between water PC and milk TBC. Water did not fulfill the quality requirements for use in sanitizing milking equipments; in spite of this fact, it was not possible to isolate its effect on milk bacteriological quality. (Author's abstract)
W88-09956

SELENIUM AND HUMAN HEALTH IMPLICATIONS IN CALIFORNIA'S SAN JOAQUIN VALLEY,
California Dept. of Health Services, Berkeley. Office of Environmental Health Assessment.
A. M. Fan, S. A. Book, R. R. Neutra, and D. M. Epstein.
Journal of Toxicology and Environmental Health JTEHD6, Vol. 23, No. 4, p 539-559, April 1988. 1 fig., 2 tab., 42 ref.

Descriptors: *Water pollution effects, Path of pollutants, *Selenium, *Kesterson National Wildlife Refuge, *Public health, *Water pollution sources, *Population exposure, Air pollution, Food toxicology, Wastewater, epidemiology, California, San Joaquin Valley.

An evaluation was conducted on the human health impacts of elevated levels of selenium in the Kesterson National Wildlife Refuge and its surroundings in Merced County, California. Investigative activities of various agencies were summarized and assessed. Agricultural waste water not intended for human use showed elevated selenium concentrations of up to 1400 ppb. Levels of selenium in fish (up to 96 ppm, wet weight), aquatic birds (up to 130 ppm in liver, dry weight), and waterfowl (up to 5.3 ppm flesh, wet weight) were unsafe for unrestricted human consumption. Data on selenium in drinking water (less than 10 ppb), animals (mean values: beef liver, 0.3-0.35 ppm, wet weight; milk, 0.01-0.02 ppm), and air (particulate, 14.8 ng per square meter; gaseous, less than 1080 ng per square meter) did not suggest a high level of exposure. Selenium concentrations in soil were highly variable and suggested a potential source of high exposure. Selenium values in blood and urine of workers were within normal range. A community health survey did not show any trend of adverse health effects in the local population. (Author's abstract)
W88-09960

LEGIONELLA PNEUMOPHILA,
John Radcliffe Hospital, Headington (England). Dept. of Virology.
J. B. Kurtz.
Annals of Occupational Hygiene AOHYA3, Vol. 32, No. 1, p 59-61, 1988. 5 ref.

Descriptors: *Legionella pneumophila, *Bacteria, *Legionnaires Disease, *Path of pollutants, *Water pollution effects, *Pneumonia, *Domestic water, *Recirculated water, *Human diseases, Public health.

Legionnaires' disease accounts for about 2 percent of community acquired pneumonia in Britain. The organism responsible, Legionella pneumophila, is ubiquitous in fresh water habitats, domestic piped water and recirculating water systems. Factors favoring colonization and control measures are discussed as well as possible virulence factors that are associated with disease related strains. (Author's abstract)
W88-09961

TWO-STAGE MINERALIZATION OF PHENANTHRENE BY ESTUARINE ENRICHMENT CULTURES,
New Hampshire Univ., Durham. Dept. of Microbiology.
W. F. Guerin, and G. E. Jones.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 4, p , April 1988. 6 fig, 1 tab, 56 ref. NOAA Grant NA-81-AA-D-0035.

Descriptors: *Polycyclic aromatic hydrocarbons, *Microbial degradation, *Fate of pollutants, *Water pollution, *Mineralization, Soil, Estuaries, microorganism, Metabolism, Isotope studies, Chromatography, Ultraviolet adsorption sepctroscopy, Phenanthrene, Biodegradation, Pollutants.

The polycyclic aromatic hydrocarbon phenanthrene was mineralized in two stages by soil, estuarine water, and sediment microbial populations. At high concentrations, phenanthrene was degraded, with the concomitant production of biomass and accumulation of Folin-Ciocalteau-reactive aromatic intermediates. Subsequent consumption of these intermediates resulted in a secondary increase in biomass. Analysis of intermediates by high-performance liquid chromatography, thin-layer chromatography, and UV absorption spectrometry showed 1-hydroxy-2-naphthoic acid (1H2NA) to be the predominant product. A less pronounced two-stage mineralization pattern was also observed by monitoring 14CO2 production from low concentrations (0.5 mg per liter) of radiolabeled phenanthrene. Here, mineralization of 14C-labeled 1H2NA could explain the incremental 14CO2 produced during the later part of the incubations. Accumulation of 1H2NA by isolates obtained from enrichments was dependent on the initial phenanthrene concentration. The production of metabolites during polycyclic aromatic hydrocarbon biodegradation is discussed with regard to its possible adaptive significance and its methodological implications. (Author's abstract)
W88-09963

TRICHLOROETHYLENE BIODEGRADATION BY A METHANE-OXIDIZING BACTERIUM,
Oak Ridge National Lab., TN. Environmental Sciences Div.
C. D. Little, A. V. Palumbo, S. E. Herbes, M. E. Lidstrom, and R. L. Tyndall.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 4, p 951-956, April 1988. 4 fig., 22 ref.

Descriptors: *Trichloroethylene, *Pollutants, *Groundwater pollution, *Chlorinated hydrocarbons, *Biodegradation, *Microbial degradation, *Bacteria, Water pollution, Biodegradation, Metabolism, Groundwater, Methanol, Methane, Radioactive tracers, Gas chromatography, Carcinogens, Methanobacteria.

Trichloroethylene (TCE), a common groundwater contaminant, is a suspected carcinogen that is highly resistant to aerobic degradation. An aerobic, methane-oxidizing bacterium was isolated that degrades TCE in pure culture at concentrations commonly observed in contaminated groundwater. Strain 46-1 a type I methanotropic bacterium, degraded TCE if grown on methane or methanol, producing CO2 and water-soluble products. Gas chromatography and C14 radiotracer techniques were used to determine the rate, methane dependence, and mechanism of TCE degradation. TCE biodegradation by strain 46-1 appears to be a cometabolic process that occurs when the organism is actively metabolizing a suitable growth substrate such as methanol or methane. It is proposed that TCE biodegradation by methanotrophs occurs by formation of TCE epoxide, which breaks down spontaneously in water to form dichloroacetic and glyoxylic acids and one carbon products. (Author's abstract)
W88-09964

TRANSFER AND OCCURRENCE OF LARGE MERCURY RESISTANCE PLASMIDS IN RIVER EPILITHON,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 2H.
W88-09965

PHENOTYPIC AND GENOTYPIC COMPARISON OF ESCHERICHIA COLI FROM PRISTINE TROPICAL WATERS,
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W88-09966

ANAEROBIC MICROBIAL DISSOLUTION OF TRANSITION AND HEAVY METAL OXIDES,
Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
A. C. Francis, and C. J. Dodge.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 4, p 1009-1014, April 1988. 4 tab, 29 ref. U.S. Department of Energy Grant DE-AC02-76CH00016.

Descriptors: *Industrial wastes, *Microbial degradation, *Path of pollutants, *Fate of pollutants, *Clostridium, *Heavy metals, Pollutants, Metal Oxides, Bacteria, Metabolism, Biodegradation, Hydrogen ion concentration, Cadmium, Copper, Lead, Zinc, Iron, Manganese, Cobalt, Nickel, Coal cleaning, Mine wastes.

Anaerobic microbial dissolution of several crystalline, water-insoluble forms of metal oxides commonly associated with the waste from energy production was investigated. An anaerobic N-fixing Clostridium sp. with acetic, butyric, and lactic acid fermentation pattern, isolated from coal-cleaning waste, solubilized Fe2O3 and MnO2 by direct enzymatic reduction; CdO, CuO, PbO, and ZnO were solubilized by direct action due to the production of metabolites and the lowering of the pH of the growth medium. Extracellular heat labile components of the cell-free spent medium obtained from culture without oxides solubilized a significant amount of Fe2O3 (1.7 micromol); however, direct contact with the bacterial cells resulted in the complete dissolution (4.8 micromol) of the oxide. Under identical conditions, the cell-free spent medium solubilized only a small amount of MnO2 (0.07 micromol), whereas 2.3 micromol of the oxide was solubilized by direct bacterial contact. Reduction of Fe2O3 and MnO2 by Clostridium spp. proceeds at different rates and, possibly, by different enzymatic systems. Fe(III) and Mn(IV) oxides appear to be used as sinks for excess electrons generated from glucose fermentation, since there is no apparent increase in the growth of the bacterium concomitant with the reduction of the oxides. Dialysis bag experiments with Co2O3 indicate that there is a slight dissolution of Co (0.16 micromol) followed by precipitation or biosorption. Although MnO2, PbO2, and Ni2O3 may undergo reductive dissolution from a higher to a lower oxidation state, dissolution by direct or indirect action was not observed. Also, CrO2 and NiO were not solubilized by direct or indirect action. Significant amounts of solubilized Cd, Cu, and Pb were immobilized by the bacterial biomass, and the addition of Cu (++) inhibited the growth of the bacterium. (Author's abstract)
W88-09967

WET WEATHER WATER QUALITY MODELING,
Texas Univ. at Dallas, Richardson. Center for Environmental Studies.
For primary bibliographic entry see Field 4C.
W88-09983

NONPOINT SOURCE POLLUTION MONITORING PROGRAM DESIGN,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W88-09985

INTERACTION OF SELENATE AND SELENITE WITH SELECTED FRESHWATER SEDIMENTS,
Saskatchewan Univ., Saskatoon. Dept. of Soil Science.
For primary bibliographic entry see Field 2H.
W88-09992

IMPACTS OF SEWAGE EFFLUENT ON TREE SURVIVAL, WATER QUALITY AND NUTRIENT REMOVAL IN COASTAL PLAIN SWAMPS,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5D.
W88-10001

NITRATE RETENTION AS IT AFFECTS GROUNDWATER POLLUTION IN MID-ATLANTIC SOILS,
Delaware Univ., Newark. Dept. of Plant Science.
D. L. Sparks.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164322/AS. Price code: A04 in paper copy; A01 in microfiche. Completion Report, September 1987. 46 p, 12 fig, 3 tab, 88 ref. Contract No. USGS 14-08-0001-G1140.

Descriptors: *Path of pollutants, *Nitrates, *Groundwater pollution, *Soil types, Mid-Atlantic region, Anions, Anion exchange capacity, Potentiometric titration, Soil adsorption, Adsorption kinetics, Water pollution sources, Electrostatic attraction.

Nitrate retention (NO3) as it affects groundwater pollution was investigated on nine major Mid-Atlantic soil types. Objectives of this study were to determine the magnitude and rate of NO3 retention; and, the effect of anion competition on NO3 retention. The soils had a wide range in organic matter, clay and oxide content. Charge properties

including anion exchange capacity (AEC) and point of zero salt effect (PZSE) were determined by Mg-Ba exchange and potentiometric titration, respectively. The PZSE values were low indicating little anion adsorption capacity while AEC values were often significant and increased with profile depth as oxide and clay contents increased. Kinetics of NO3 retention and release and the effect of competitive anions on NO3 retention were investigated at pH 4.0, 5.5, and 7.0 using a stirred flow method. Nitrate retention was highest at pH 4.0 and was strongly correlated with clay and oxide contents. The adsorption kinetics were rapid and completely reversible indicating the NO3 adsorption mechanism is electrostatic. Several soils including the Cecil, Dothan, and Matapeake adsorbed considerable NO3 at pH 4.0 while the Evesboro soil adsorbed little NO3. Whenever SO4 was present, NO3 retention significantly decreased and was even depressed when Cl was added. (USGS)
W88-10006

EFFECTS OF TILLAGE SYSTEM, CROP RESIDUE LEVEL, AND FERTILIZER APPLICATION TECHNIQUE ON LOSSES OF PHOSPHORUS AND PESTICIDES FROM AGRICULTURAL LANDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
S. Mostaghimi, V. O. Shanholtz, T. A. Dillaha, A. L. Kenimer, and B. B. Ross.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88 163837/AS. Price codes: A05 in paper copy; A01 in microfiche. Virginia Water Resources Research Center, Blacksburg, Bulletin 157, September 1987. 74 p, 9 fig, 17 tab, 39 ref, append.

Descriptors: *Best management practices, *Virginia, *Rainfall simulator, No-till, Conventional tillage, Atrazine, 2,4-D, Phosphorus, Application technique, Crop residue level, Pesticide residues, Water pollution sources.

A rainfall simulator was used to study the effectiveness of three best management practices - no-till, residue level and fertilizer application technique. Simulated rainfall was applied to 12 experimental field plots, each 0.01 ha in size. The plots were divided into conventional and no-tillage systems. During phase I of the study, the effectiveness of two fertilizer application methods - subsurface injection and surface application - were investigated for the two tillage systems. In phase II, three crop residue levels - 0, 750, and 1500 kg/ha - were studied within each tillage system. Nitrogen and phosphorus fertilizers were applied at rates of 147 and 46 kg/ha, respectively. Atrazine and 2,4-D were applied at the rates of 2.24 and 0.56 kg/ha, active ingredient, respectively. Fertilizer and herbicide were applied 24 to 48 hours before the start of rain simulation. No-till was very effective in reducing runoff and sediment losses. No-till with high residue level produced the greatest reductions in runoff and sediment losses, and the highest reduction for both runoff (92%) and sediment (98%) occurred with no-till and 1500 kg/ha crop residue level. The injection fertilization method reduced O-P losses by 39% for no-till and 35% for conventional tillage. Reductions in T-P losses due to no-till were 89% and 91% for surface and injection fertilizer application methods, respectively. Averaged across all fertilizer treatments, an equivalent of 0.9% and 8.9% of the total-P fertilizer applied to the plots was lost from no-till and conventional tillage plots, respectively. Concentrations of atrazine and 2,4-D in runoff and sediment were greater from the no-till plots than from the conventional plots, but total losses were less. Water was the major carrier for both herbicides, although the concentration of 2,4-D in sediment was higher than that of water. Averaged over all plots, the atrazine losses were 2.9% of the applied amount for conventional tillage and 0.3% for no-tillage. The corresponding values for 2,4-D were 0.3% and 0.02. (USGS)
W88-10025

EFFECTIVENESS OF BMPS FOR STORMWATER MANAGEMENT IN URBANIZED WATERSHEDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
C. Y. Kuo, G. V. Loganathan, W. E. Cox, S. P. Shrestha, and K. J. Ying.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-167309/AS. Price codes: A06 in paper copy; A01 in microfiche. Virginia Water Resources Research Center, Blacksburg, Bulletin 159, January 1988. 121 p, 36 fig, 16 tab, 39 ref. State Project No. 238768-7.

Descriptors: *Best management practices, *Simulation analysis, *Virginia, Hydrographs, Model studies, Drainage area simulation, Upper Holmes run watershed, Urban watersheds, Stormwater management, Water shed management, Water pollution sources.

The Illinois Urban Area Simulator (ILLUDAS) has been modified for continuous simulation and a water quality module has been added to it. The continuous simulation model updates the Antecedent Moisture Condition (AMC) based on the rainfall information up to 120 hours prior to the beginning of a storm and the information on the number of dry days between storms is utilized to compute the pollutant build-up which also depends on the street sweeping interval. The water quality module utilizes the dust and dirt method of STORM to compute pollutant accumulated on the watershed surface. Pollutant washoff is then computed based on the assumption of first-order kinetics. Features have been added to simulate the effect of BMP structures. An optimization scheme has been adopted to optimally size and locate the detention structure within the watershed. The model has been verified using the observed data from the Upper Holmes Run Watershed in Northern Virginia and a hypothetical watershed, basin Alpha, originally described in ILLUDAS. An institutional framework for urban stormwater management is delineated. The role of federal, state, and local agencies in urban stormwater management is discussed. (USGS)
W88-10029

POWERBOAT ENGINE DISCHARGES AS A NUTRIENT SOURCE IN HIGH-USE LAKES,
Idaho Univ., Moscow. Dept. of Fish and Wildlife.
D. Hallock, and C. M. Falter.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-186333/AS. Price codes: A04 in paper copy; A01 in microfiche. Idaho Water Resources Research Institute, Moscow, Completion Report. October 1987. 45 p, 7 fig, 3 tab, 27 ref. Contract No. 14-08-0001-G1222. Project No. USGS G1222-06.

Descriptors: *Nutrients, *Load distribution, *Water pollution sources, *Powerboat engine discharge, Nitrogen compounds, Phosphorus compounds, Nitrogen oxides, Idaho, Twin Lakes.

Modern internal combustion engines burn fuels containing various nitrogen and phosphorus compounds as additives, eg, alkyl phosphate, amine phosphate, etc. Nitrogen oxides are also formed from atmospheric gases during the combustion process. In the case of marine engines, exhaust gases and incompletely burned fuel and oil are discharged directly into the water. In-situ enclosure experiments were conducted to quantify nitrogen and phosphorus additions and the biological responses from two- and four-cycle outboard engines. The modern two-cycle outboard engine produced 300 mg total nitrogen and 1.0 mg total phosphorus per liter fuel consumed. The 1970 untuned two-cycle outboard produced 180 mg N and 0.9 mg P and the new four-cycle outboard produced 90 mg N and 0.0 mg P per liter fuel consumed. The untuned two-cycle outboard consumed about three times as much fuel as the other two engines. The biological response was moderate considering the concentrated nature of the tests. A motorboat census was conducted on Twin Lakes, Kootenai County, Idaho, throughout the 1986 boating season and annual fuel consumption was estimated. Phosphorus and nitrogen loading to Twin Lakes from motorboat engine discharges were calculated and are low when compared to loading from other sources. (USGS)
W88-10035

ANALYTICALLY-DERIVED SENSITIVITIES IN ONE-DIMENSIONAL MODELS OF SOLUTE TRANSPORT IN POROUS MEDIA,
Geological Survey, Reston, VA. Water Resources Div.
D. S. Knopman.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Open-File Report 86-605, 1987. 97 p, 1 tab, 4 ref, append.

Descriptors: *Model studies, *Solute transport, *Path of pollutants, *Groundwater movement, *Computer programs, Sensitivity analysis, Porous media, FORTRAN, Advection-dispersion equation, Parameter estimation.

Analytically-derived sensitivities are presented for parameters in one-dimensional models of solute transport in porous media. Sensitivities were derived by direct differentiation of closed form solutions for each of the models, and by a time integral method for two of the models. Models are based on the advection-dispersion equation and include adsorption and first-order chemical decay. Boundary conditions considered are: a constant step input of solute, constant flux input of solute, and exponentially decaying input of solute at the upstream boundary. A zero flux is assumed at the downstream boundary. Initial conditions include a constant and spatially varying distribution of solute. One model simulates the mixing of solute in an observation well from individual layers in a multilayer aquifer system. Computer programs produce output files compatible with graphics software in which sensitivities are plotted as a function of either time or space. (USGS)
W88-10048

CALIBRATION OF A DISSOLVED-SOLIDS MODEL FOR THE YAMPA RIVER BASIN BETWEEN STEAMBOAT SPRINGS AND MAYBELL, NORTHWESTERN COLORADO,
Geological Survey, Lakewood, CO. Water Resources Div.
R. S. Parker, and D. W. Litke.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources Investigations Report 86-4190, 1987. 36 p, 16 fig, 11 tab, 9 ref.

Descriptors: *Model studies, *Water quality, *Colorado, *Yampa River, *Water pollution sources, *Mine drainage, Coal mining, Streamflow, Stream discharge.

The cumulative effects of changes in dissolved solids from a number of coal mines are needed to evaluate effects on downstream water use. A model for determining cumulative effects of streamflow, dissolved-solids concentration, and dissolved-solids load was calibrated for the Yampa River and its tributaries in northwestern Colorado. The model uses accounting principles. It establishes nodes on the stream system and sums water quantity and quality from node to node in the downstream direction. The model operates on a monthly time step for the study period that includes water years 1976 through 1981. Output is monthly mean streamflow, dissolved-solids concentration, and dissolved-solids load. Streamflow and dissolved solids data from streamflow-gaging stations and other data-collection sites were used to define input data sets to initiate and to calibrate the model. The model was calibrated at four nodes and generally was within 10% of the observed values. The calibrated model can compute changes in dissolved-solids concentration or load resulting from the cumulative effects of new coal mines or the expansion of old coal mines in the Yampa River basin. (USGS)
W88-10050

SURFACE WATER-QUALITY CHARACTERISTICS IN THE UPPER NORTH FORK GUNNISON RIVER BASIN, COLORADO,
Geological Survey, Lakewood, CO. Water Resources Div.
J. M. Norris.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources In-

vestigations Report 86-4152, 1987. 42 p, 12 fig, 20 tab, 5 ref.

Descriptors: *Water quality, *Gunnison River, *Colorado, *Hydrological data collections, *Surface water, Dissolved constituents, Trace elements.

Analyses of water-quality data collected during 1982 and 1983 in the upper North Fork Gunnison River basin indicate that dissolved-solids concentrations are relatively small, with a mean value near 97 ml/g per liter. Most major dissolved constituents also had small measured concentrations throughout the study area. Trace-element concentrations generally were small; however, total-iron concentration generally was large in the area with a mean concentration of about 8,250 micrograms per liter. The cause of this larger iron concentration probably is related to the local geology. Paonia Reservoir, located on Muddy Creek, greatly reduced suspended-sediment and trace-element concentrations. The reservoir had only a slight effect on major dissolved-constituent concentrations. Analyses of alkalinity, sulfate, and dissolved-solids concentrations indicated that little, if any, changes in water quality occur as a result of coal mining; however, more data are needed to make more definite conclusions. Sulfate concentrations increased slightly downstream through the mined area; however, with the small concentrations measured and limited quantity of data, the source of the increased sulfate could not be determined. (USGS)
W88-10051

HYDROLOGY OF THE WHITE TAIL BUTTE AREA, NORTHERN CAMPBELL COUNTY, WYOMING,
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 4C.
W88-10052

EFFECT OF URBANIZATION ON THE WATER RESOURCES OF EASTERN CHESTER COUNTY, PENNSYLVANIA,
Geological Survey, Malvern, PA. Water Resources Div.
R. A. Sloto.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources Investigations Report 87-4098, 1987. 131 p, 41 fig, 31 tab, 55 ref.

Descriptors: *Urban hydrology, *Urban runoff, *Water pollution sources, *Pennsylvania, *Water quality, Groundwater, Urbanization, Organic compounds, Chester County.

The effects of human activities on the water resources of a 207-square-mile area of eastern Chester County, Pennsylvania, were evaluated. The most serious consequence of urbanization is the contamination of groundwater by volatile organic compounds, which were detected in 39 percent of 70 wells sampled. Total phenol was detected in 28 percent of 54 wells sampled. A few pesticides and base-neutral compounds were detected in small concentrations. Concentrations of chloride as high as 2,100 milligrams per liter were found in a well at a former highway-salt-storage site. Wells downgradient from the Pennsylvania Turnpike in carbonate rock had elevated chloride concentrations. The growth of public water and sewer system has resulted in a significant interbasin transfer of water; estimates for 1984 range from a net loss of 630 million gallons in the Valley Creek basin to a net gain of 783 million gallons in the Chester Creek basin. Groundwater seepage to sewers is substantial and can be as much as 4.5 million gallons per day. Land use changes in 10 selected subbasins were quantified and related to benthic-invertebrate diversity index. Subbasins that had a greater change in land use had a greater increase in diversity index. Subbasins that had a greater change in land use had a greater increase in diversity index. The increase may result from the banning of persistent pesticides such as DDT, to a decreasing use of pesticides in urban subbasins, and/or the flushing or burial of older, pesticide-contaminated sediment. (USGS)
W88-10054

HYDROLOGY OF AREA 53, NORTHERN GREAT PLAINS AND ROCKY MOUNTAINS COAL PROVINCES, COLORADO, WYOMING, AND UTAH,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W88-10055

SELECTED WATER-QUALITY DATA FOR THE MINIDOKA IRRIGATION DISTRICT, SOUTH-CENTRAL IDAHO, JUNE 1987,
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W88-10057

DISCHARGE AND WATER QUALITY OF SPRINGS IN ROAN AND PARACHUTE CREEK BASINS, NORTHWESTERN COLORADO, 1981-83,
Geological Survey, Grand Junction, CO. Water Resources Div.
For primary bibliographic entry see Field 2K.
W88-10062

DETERMINATION OF BENTHIC-INVERTEBRATE INDICES AND WATER-QUALITY TRENDS OF SELECTED STREAMS IN CHESTER COUNTY, PENNSYLVANIA, 1969-80,
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 5A.
W88-10063

SURFACE-WATER-QUALITY ASSESSMENT OF THE UPPER ILLINOIS RIVER BASIN IN ILLINOIS, INDIANA, AND WISCONSIN: PROJECT DESCRIPTION,
Geological Survey, Urbana, IL. Water Resources Div.
D. M. Mades.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Open-File Report 87-473, 1987. 35 p, 6 fig, 2 tab, 51 ref.

Descriptors: *Water quality, *Hydrologic data collections, *Surface water, *Water quality, Planning, Regional analysis, Illinois River basin, Eutrophication, Illinois, Indiana, Sediment chemistry, Sediment discharge, Trace elements, Water pollution control, Wisconsin.

In 1986, the U.S. Geological Survey began a National Water-Quality Assessment program to provide nationally consistent descriptions of the current status of water quality; to define, where possible, trends in water quality; and to describe the relation between water quality and natural and land-use factors. The program presently is in a pilot phase that will test and modify, as necessary, concepts and approaches in preparation for future full implementation of the program. The upper Illinois River basin in one of four basins selected to test the concepts and approaches of the surface-water-quality element of the national program. The basin drains 10,949 square miles of Illinois, Indiana, and Wisconsin. Land use is predominantly agricultural; about 75 percent is cultivated primarily for production of corn and soybeans. About 13 percent of the basin is urban area, most of which is located in the Chicago metropolitan area, and about 7 million people live in the basin. Many of the major water-quality issues in the basin are related to sediment, nutrients, and potentially toxic inorganic and organic constituents. Occurrences of these constituents in the rivers and lakes within the basin may adversely affect the water's suitability for aquatic life and recreation and, through the consumption of fish, human health. (USGS)
W88-10066

PESTICIDE DATA FOR SELECTED WYOMING STREAMS, 1976-78,
Geological Survey, Cheyenne, WY. Water Resources Div.
D. L. Butler.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources Investigations Report 83-4127, 1987. 41 p, 1 fig, 10 tab, 9 ref.

Descriptors: *Organophosphorus pesticides, *Herbicides, *Polychlorinated biphenyls, *Data collections, *Organochlorine insecticides, Water quality, Streams, Toxicity, Polychlorinated napthalenes, North Platte River, Wind River, Bighorn basin, Bear River, Green River basin, Powder River, Picloram, Dicamba.

In 1976, the U.S. Geological Survey, in cooperation with the Wyoming Department of Agriculture, started a monitoring program to determine pesticide concentrations in Wyoming streams. This program was incorporated into the water-quality data-collection system already in operation. Samples were collected at 20 sites for analysis of various insecticides, herbicides, polychlorinated biphenyls, and polychlorinated napthalenes. The results through 1978 revealed small concentrations of pesticides in water and bottom-material samples were DDE (39 percent of the concentrations equal to or greater than the minimum reported concentrations of the analytical methods), DDD (20 percent), dieldrin (21 percent), and polychlorinated biphenyls (29 percent). The herbicides most commonly found in water samples were 2,4-D (29 percent of the concentrations equal to or greater than the minimum reported concentrations of the analytical method) and picloram (23 percent). Most concentrations were significantly less than concentrations thought to be harmful to freshwater aquatic life based on available toxicity data. However for some pesticides, U.S. Environmental Protection Agency water-quality criteria for freshwater aquatic life are based on bioaccumulation factors that result in criteria concentrations less than the minimum reported concentrations of the analytical methods. It is not known if certain pesticides were present at concentrations less than the minimum reported concentrations that exceeded these criteria. (USGS)
W88-10067

REGIONALIZED VARIABLE THEORY AND THE ASSESSMENT OF THE CONSEQUENCES OF UNCERTAINTY IN THE OPTIMAL DESIGN OF WATER QUALITY SAMPLING NETWORKS,
Wisconsin Univ., Milwaukee. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W88-10080

ANALYSIS OF WATER QUALITY MODEL UNCERTAINTY USING A BAYESIAN MONTE CARLO METHOD,
Michigan Univ., Ann Arbor. Dept. of Environmental Health.
For primary bibliographic entry see Field 6A.
W88-10081

COMPUTER SIMULATION OF ALDICARB MIGRATION AND DEGRADATION IN THE SAND PLAIN OF CENTRAL WISCONSIN,
Wisconsin Univ.-Madison. Environmental Toxicology Center.
F. A. Jones.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8708092. Ph.D Dissertation, 1987. 155 p, 15 fig, 22 tab, 51 ref, 3 append.

Descriptors: *Path of pollutants, *Aldicarb, *Model studies, *Groundwater pollution, *Insecticides, *Water quality, *Computer programs, Mathematical models, Simulation analysis, Leaching, Agricultural chemicals, Agricultural runoff, Pesticides.

An unsaturated zone model was combined with a saturated one to simulate the fate of aldicarb between application and degradation to nontoxic residues in the groundwater in the sand plain of central Wisconsin. Groundwater quality beneath agricultural fields was monitored to provide information on the transport and attenuation of aldi-

carb. Field observations and simulations indicate that aldicarb residues are still entering Wisconsin groundwater under present use practices. Reduction in application rate and delay in the date of application by 28 days reduced the amount of residues entering the groundwater. But these measures are insufficient to prevent leaching of aldicarb to groundwater in concentrations greater than the 10 ppb state guideline. The linked unsaturated and saturated zone transport model furnishes better estimates of the percentage of applied aldicarb entering the groundwater and the rate at which the aldicarb residues within the groundwater attenuate. (Cremmins-AEPCO)
W88-10082

5C. Effects Of Pollution

IMPACT OF ACID RAIN AND DEPOSITION ON AQUATIC BIOLOGICAL SYSTEMS.
American Society for Testing and Materials, Philadelphia, PA. Committee D-19 on Water.
A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. 114 p. Edited by Billy G. Isom, Sally D. Dennis, and John M. Bates.

Descriptors: *Acid rain, *Water pollution effects, *Aquatic environment, *Environmental effects, Acidification, Air pollution, Soil contamination, Fish, Toxicity, Chemical analysis, Field tests, Surveys, Symposium.

This volume brings together a diverse group of papers that have been used to link sources of acidification to aquatic biological effects. Air, water, soil (sediment), toxicology, and biological papers contribute to our understanding of lake/stream acidification processes and aquatic biological effects such as toxicity, productivity, and diversity. Sections that describe the scope and organization of the assessment and a list of policy-related questions presented in the context of an Adirondack Mountain and New York regional case study are of particular interest. Fish are the principal biotic resource considered in the case study. Especially discussed are the uncertainties of: (1) the inferential process of relating acid deposition to loss of fish populations; (2) the application of laboratory-derived, dose-response functions to field situations; (3) the correlating of chemistry to fish field surveys, some of which do not take factors into account such as fishing pressure, historical stocking practices, habitat changes, etc. that are necessary to identify the contribution of acid-deposition effects. The conceptual basis for an environmental model of reduced fishing benefits related to acidification is addressed also. (See W88-08961 thru W88-08969) (Lantz-PTT)
W88-08960

ASSESSMENT OF AQUATIC EFFECTS DUE TO ACID DEPOSITION,
Environmental Protection Agency, Washington, DC.
J. L. Malanchuk, P. A. Mundy, R. J. Nesse, and D. A. Bennett.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 4-16, 3 fig, 1 tab, 18 ref.

Descriptors: *Acid rain, *Water pollution effects, *Aquatic environment, Assessments, Planning, Data interpretation.

Increased concern over the impact of acid deposition on natural resources has caused the proliferation of substantial research in the area of effects. Often overlooked is the synthesis of this vast body of information into a coherent picture to be used for assessment and policy analysis. Relationships among research projects frequently are poorly defined or lacking, and problems of spatial and temporal resolution are abundant. The acquisition and use of historical data, for example, water quality and fish stocking data, to determine trends over time is problematical. Assessments of aquatic effects will be made in 1985, 1987, and 1989 under the National Acid Precipitation Assessment Program. A procedure is presented which attempts to organize existing information over space and time. Problems are highlighted and information needs made apparent. (See also W88-08960) (Author's abstract)
W88-08961

PRELIMINARY ASSESSMENT OF THE IMPORTANCE OF LITTORAL AND BENTHIC AUTOTROPHIC COMMUNITIES IN ACIDIC LAKES,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
For primary bibliographic entry see Field 2H.
W88-08962

EFFECTS OF SHORT-TERM AND CONTINUOUS EXPERIMENTAL ACIDIFICATION ON BIOMASS AND PRODUCTIVITY OF RUNNING WATER PERIPHYTIC ALGAE,
Quebec Univ., Montreal. Dept. of Biological Sciences.
L. Parent, M. Allard, D. Planas, and G. Moreau.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 28-41, 4 fig, 3 tab, 46 ref.

Descriptors: *Stream biota, *Water pollution effects, *Algae, *Acidification, *Simulation analysis, *Biomass, *Periphyton, *Acid rain, *Primary productivity, *Epiphytes, Hydrogen ion concentration, Sulfuric acid.

The effect of short-term and continuous acidification on the primary production and biomass of periphyton was studied in seminatural conditions using an experimental device simulating streams ecosystems. After allowing periphytic algae to colonize unglazed ceramic tiles for 4 to 6 weeks under natural conditions, the pH of the water was lowered with sulfuric acid (H_2SO_4) from 6.5 to 6.7 to 4 to 4.6 for short periods (12 to 72 h) or long periods (continuous acidification, 84 days). During short-term acidification, in all the experiments but one, there was a significant increase (up to 2.6 times as compared to the control) of the primary production and specific activity in the first 12 h, followed by a significant decrease and slow recovery from 48 h until the end of the experiment. If acidification is continuous, primary production and specific activity are significantly higher (between 10 to 15 times that of the control) in acidified channels, either with or without aluminum, by Day 33 and until the end. Biomass stayed constant or decreased in short-term acidification and increased (from 10 to 15 times) in continuous acidification. (See also W88-08960) (Author's abstract)
W88-08963

RELATIONSHIPS OF SPATIAL GRADIENTS OF PRIMARY PRODUCTION, BUFFERING CAPACITY, AND HYDROLOGY IN TURKEY LAKES WATERSHED,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W88-08964

SIZE-DEPENDENT SENSITIVITY OF THREE SPECIES OF STREAM INVERTEBRATES TO PH DEPRESSION,
Michigan State Univ., East Lansing. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W88-08965

LINKING AUTOMATED BIOMONITORING TO REMOTE COMPUTER PLATFORMS WITH SATELLITE DATA RETRIEVAL IN ACIDIFIED STREAMS,
Tennessee Technological Univ., Cookeville. Center for the Management, Utilization and Protection of Water Resources.
E. L. Morgan, K. W. Eagleson, T. P. Weaver, and B. G. Isom.
IN: Impact of Acid Rain and Deposition on Aquatic Biological Systems. A Symposium Sponsored by the American Society for Testing Material Committee D-19 on Water, Bal Harbour, Florida, October 29, 1984. ASTM Special Technical Publication No. 928, 1986. p 84-91, 1 fig, 8 ref.

Descriptors: *Acid rain effects, *Water pollution effects, *Monitoring, *Remote sensing, *Acidic waters, *Streams, Satellite technology, Automation, Biological studies, Fish physiology, Water quality control, Networks, Computers.

Recent advances in site-specific detection of physiological responses in fish to continuous stream flows now complement surveillance programs utilizing remote automated water quality monitoring stations. Developments in automated biosensing provide methods for measuring in situ fish breathing rate changes to stream episodes and add a real-time biological monitoring dimension to remote water quality networks incorporating automated data collection platforms and satellite data retrieval options. In meeting the objective of developing automated biosensing capabilities for remote monitoring, a series of field trials was designed to test various configurations of in situ fish-holding chambers, breathing rate detectors, and system interface to streamside water quality data collection platforms for satellite data retrieval. Results were used to design groups of automated biosensing devices for detecting rainbow trout breathing rate responses and to implement eight units at each of two data collection, platform-equipped, water quality stations located along a stream subject to acid precipitation influences in the Southern Appalachian Mountains. Remote stations are being maintained for real-time data needs as a part of the 5-year Acid Precipitation Mitigation Program initiated in 1985 by the U.S. Fish and Wildlife Service to evaluate stream ecological responses to regulated liming operations. (See also W88-089600 (Author's abstract)
W88-08967

CONSIDERATION OF TOTAL ION COMPOSITION IN DESIGNING TOXICITY TESTS USING ALUMINUM SALTS AND MINERAL ACIDS,
ADVENT Group, Brentwood, TN.
For primary bibliographic entry see Field 5A.
W88-08968

1987 ANNUAL BOOK OF ASTM STANDARDS.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 7B.
W88-08986

HUMIC SUBSTANCES REDUCE BIOAVAILABILITY AND TOXICITY OF CONTAMINANTS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5B.
W88-09036

APPROACHES TO THE ASSESSMENT OF INJURIES TO SOIL ARISING FROM DISCHARGES OF HAZARDOUS SUBSTANCES AND OIL,
Battelle Pacific Northwest Labs., Richland, WA.
P. Van Voris, G. W. Dawson, J. K. Fredrickson, D. A. Cataldo, and L. E. Rogers.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-011629. Price codes: A04 in paper copy, A01 in microfiche. June 1987. 47 p, 1 fig, 64 ref, append. Contract No. DE-AC06-76RL01830.

Descriptors: *Soil contamination, *Environmental impact statement, *Leaching, *Hazardous wastes, *Oil, Soil physical properties, Path of pollutants, Soil properties, Soil porosity, Soil stability, Vege-

tation, Soil bacteria, Soil water potential, Food chains, Baseline studies.

This report provides useful information for natural resource damage assessment involving potential injury to the soil portion of the geologic resource. It supplies descriptive information on methods for determining the nature and magnitude of injury to soil chemical, physical, and biological characteristics, as well as contaminant transport potential through leaching or the food chain. In addition, this document explains how injuries to the soil resource can be translated into a reduction in services provided by that soil in comparison to local baseline (uninjured) soils. It also provides information important in determining both the ability and time necessary for the soil to recover from the injury. That portion of the regulations contained in 43 CFR Part 11 that pertain to the soils portion of the geologic resource are explained. (Geiger-PTT)
W88-09046

SOURCES OF PHOSPHATE WHICH GIVE RISE TO EUTROPHICATION IN SOUTH AFRICAN WATERS,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5B.
W88-09047

PHOSPHATE DYNAMICS IN AQUATIC ECOSYSTEMS,
National Inst. for Water Research, Pretoria (South Africa).
R. D. Robarts, and J. A. Thornton.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-226221. Price codes: E04 in paper copy, A01 in microfiche. 1985. 16 p, 5 fig, 2 tab, 22 ref.

Descriptors: *Phosphates, *Lakes, *Lake sediments, *Path of pollutants, *Eutrophication, *Reservoirs, *Nutrient cycling, Sediment transport, Hartbeespoort Dam, South Africa, Phosphorus, Ecosystems, Algae, Eutrophic lakes, Bacteria.

The major aspects of phosphorus dynamics in aquatic ecosystems are revealed using data from Hartbeespoort Dam (South Africa). The most important form of inorganic phosphorus is orthophosphorus and in lakes such as Hartbeespoort Dam it usually contributes greater than 60% to the inorganic phosphorus pool. In most lakes, the net flux of phosphorus on a yearly basis is towards the sediments. However, and especially in eutrophic lakes, the release of phosphorus from the sediments may exceed the sedimentation input. Before sediments release phosphorus they must be phosphorus saturated. Unlike sediment-water phosphorus dynamics, phosphorus cycling in the water column proceeds on much shorter time scales, usually from minutes to a few days at most. In the water column, algae are usually the dominant organisms taking up and releasing phosphorus but recent data from nutrient poor systems indicate that bacteria can equal the importance of algae in the biogeochemical cycling of phosphorus. (Author's abstract)
W88-09050

PREDICTING THE TROPHIC STATUS OF RESERVOIRS IN SEMI-ARID REGIONS,
National Inst. for Water Research, Pretoria (South Africa).
D. C. Grobler.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-226205. Price codes: E04 in paper copy, A01 in microfiche. 1985. 17 p, 6 fig, 2 tab, 16 ref.

Descriptors: *Eutrophication, *Reservoir Eutrophication Model, *Mathematical models, *Reservoirs, *Hydrologic models, *Phosphorus, *Semi-arid lands, Runoff, Eutrophic lakes, Trophic level, Sediment load, South Africa, Decision making, Water pollution prevention, Water pollution control, Model studies, Stochastic process, Lakes.

Most of South Africa has a semi-arid to arid climate and characteristically experiences runoff, nutrient loads and water levels in reservoirs that are highly erratic and seasonal. In such regions eutrophication models such as the OECD model, have limited value as decision-making aids. The Reservoir Eutrophication Model (REM) was developed to include the effects of hydrological variability when predicting the trophic status of reservoirs in semi-arid regions. The REM consists of a series of interlinked models which are used to simulate time series of inflows, total phosphorus loads, water levels in the reservoirs, outflows, and total phosphorus concentrations in the reservoirs. The REM also contains models for simulating the trophic response of the reservoirs to their simulated total phosphorus concentrations. The REM takes into account the stochastic nature of the variables driving the eutrophication process, whereas the OECD model uses only their mean values. The REM model also simulates the dynamic behavior of reservoirs, whereas the OECD model only simulates the response of a system assumed to be at steady state. (Geiger-PTT)
W88-09051

FINANCIAL IMPLICATION OF EUTROPHICATION,
National Inst. for Water Research, Pretoria (South Africa).
F. C. Vilgoen, and R. E. Haynes.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-226247. Price codes: E04 in paper copy, A01 in microfiche. 1985. 17 p, 3 fig, 4 tab, 18 ref.

Descriptors: *Water pollution effects, *Economic aspects, *Eutrophication, *Impaired water use, *Water use, Water demand, Legal aspects, Riparian rights, Recreation, Boating, Swimming, Fishing, Water treatment, Agriculture, Industrial water, Macrophytes, Algae, Algal toxins, South Africa.

The financial implications of eutrophication to the community are explored by examining five activities that may be affected by eutrophication: recreation, riparian ownership, water purification, industry, and agriculture. Water-based activities such as boating, boating-related sports, riverbank recreation and angling, constitute an important component of a community's recreational requirements. Eutrophication-related problems and constraints significantly affect the quality of water-based recreation both on or near any water body. The financial impact of a reduction in recreational usage of the Barrage Reservoir (South Africa) due to eutrophication is estimated for the 1984/1985 season. The total approximated annual input (Barrage only) into the economy from recreation and riparian property expressed as rands per river kilometer or rands per hectare water surface is Rand (R) 392,857 and R32,679, respectively. Costs that may be debited to the consumers account as a result of the inclusion of various algal control options (e.g., covering filters, chlorination, chlorine dioxide, microscreening, flotation, and activated carbon) during water treatment are listed. Eutrophication related problems experienced by industry include blockages of intake pumps, canals, and pipes and general unacceptability of the water quality for specific applications. In agricultural use, many algal species are toxic to stock and the presence of these species may render water unsafe for animal watering. Over-abundant growth of filamentous algae and macrophytes may block pump intakes and irrigation systems. Excessive growth of algae and macrophytes in irrigation canals requires costly cleaning measures. (Geiger-PTT)
W88-09052

RESISTANCE AND RESILIENCE OF POND AND STREAM ECOSYSTEMS TO TOXICANT STRESS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
H. L. Boston, A. J. Stewart, A. R. Johnson, and S. M. Bartell.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-008804. Price codes: A02 in paper copy, A01 in microfiche. 1987. 8 p, 4 fig, 1 tab. Contract No. DE-AC05-84OR214000.

Descriptors: *Water pollution effects, *Ponds, *Resistance, *Toxicity, *Model studies, *Resilience, *Stress, Ecosystems, Stability analysis, Organic matter, Classification, Oak Ridge, Tennessee, Streams, Cycling nutrients, Grazing, Models, Water quality.

This project summary describes work in progress in modeling the responses of ponds and streams to perturbation. Hypotheses concerning the resistance and resilience of aquatic ecosystems exposed to toxic chemicals will be evaluated to develop diagnostic criteria for ecosystem classification and to improve existing methods of ecological risk estimation. The underlying rate structure in pond and stream systems (including, production, herbivory, nutrient uptake and recycling) is to be quantified, and the changes in pond and stream structures in response to perturbations by toxicants will be measured. Several theories relating to ecosystem resistance and resilience were evaluated by a three component approach. First, manipulative experiments will be conducted in the Oak Ridge National Laboratory ponds to quantify system response to addition of phenolic compounds. Secondly, the response and recovery of streams following exposure to toxicant stress will be examined using several streams located on the Oak Ridge Reservation. Third, ecosystem modeling of toxic effects in the ponds and streams is to be undertaken. Site-specific simulation models will be developed for the studied ponds and streams from existing models that might be appropriate with sufficient modification. (Geiger-PTT)
W88-09055

RISK ASSESSMENT AT HAZARDOUS WASTE SITES.
For primary bibliographic entry see Field 5E.
W88-09056

DETERMINING THE IMPACTS ON HUMAN HEALTH ATTRIBUTABLE TO HAZARDOUS WASTE SITES,
Centers for Disease Control, Atlanta, GA. Center for Environmental Health.
V. N. Houk.
IN: Risk Assessment at Hazardous Waste Sites. American Chemical Society, Washington, DC. 1982. p 21-32, 1 fig, 2 tab, 15 ref.

Descriptors: *Hazardous wastes, *Public health, *Waste dumps, *Risks, *Population exposure, Epidemiology, Water pollution effects, Superfund Act, Legal aspects, Waste management, Hazardous materials, Toxicity, Toxic wastes, Case studies, Environmental effects.

The Superfund Act and implementing Executive Order assign to the Department of Health and Human Services the responsibility for assessing the threat hazardous waste sites pose to the health of workers and the general public. The working definition for such a health risk assessment is the determination of probabilities of various adverse health outcomes that result or would result from exposure to specified hazards. To fulfill the legal mandate, the Department of Health and Human Services intends first to determine the nature and quantity of toxic materials present at Superfund sites, the size and proximity of potentially exposed human populations, and the existence of likely pathways for significant human exposure. If all three factors are present, additional study through various approaches, such as exposure documentation studies, disease-related epidemiologic studies, or disease registries, will be considered. (See also W88-09056) (Author's abstract)
W88-09059

INDUSTRY'S GUIDELINES FOR RISK ASSESSMENT,
Shell Oil Co., Houston, TX.
For primary bibliographic entry see Field 5E.
W88-09060

INCORPORATING RISK ASSESSMENT INTO THE RESOURCE CONSERVATION AND RECOVERY ACT REGULATORY PROCESS,
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 6E.
W88-09064

METAL SPECIATION IN NATURAL WATERS: INFLUENCE OF ENVIRONMENTAL ACIDIFICATION,
Quebec Univ., Sainte-Foy.
P. G. C. Campbell, and A. Tessier.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 185-207, 4 fig, 8 tab, 48 ref.

Descriptors: *Metals, *Lakes, *Chemical speciation, *Acid rain effects, *Acidic water, *Natural waters, *Hydrogen ion concentration, Gold, Aluminum, Cadmium, Cobalt, Copper, Mercury, Manganese, Nickel, Lead, Zinc, Heavy metals, Acidity, Acid streams, Geochemistry, Chemical properties.

Changes in metal speciation in solution that may result from an increase in the acidity of natural waters over the pH range from 7 to 4 are reviewed. Attention is focused on 10 metals (Ag, Al, Cd, Co, Cu, Hg, Mn, Ni, Pb, and Zn) that exist in cationic forms and are of potential concern in the context of freshwater acidification. For those metals for which changes in the degree of complexation (delta pM and delta pM prime) as a function of pH have been studied experimentally, reasonable qualitative agreement with their predicted sensitivity to pH changes is observed. For two of the metals (Al and Cu), important changes in both inorganic and organic speciation are predicted over the pH range from 7 to 4; confirmatory experimental data are available for Cu, whereas for Al the observed changes in delta pM prime appear to be less important than predicted. In contrast, observed changes in delta pM prime for Pb in organic-rich systems are much greater than would be predicted from equilibrium calculations. Calculations for Hg suggest that its (inorganic) speciation should vary markedly over the studied pH range, but no unambiguous experimental data relating to pH-induced changes in Hg speciation could be found. In the six remaining cases, predicted to show little sensitivity to pH changes in this range, supporting experimental evidence exists for four metals (Ag, Cd, Mn, and Zn). (See also W88-09065) (Author's abstract)
W88-09072

MECHANISMS OF ALKALINITY GENERATION IN ACID-SENSITIVE SOFT WATER LAKES,
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
P. L. Brezonik, L. A. Baker, and T. E. Perry.
IN: Sources and Fates of Aquatic Pollutants. American Chemical Society, Washington, DC. 1987. p 229-260, 8 fig, 1 tab, 58 ref.

Descriptors: *Acid rain, *Water chemistry, *Limnology, *Lakes, *Alkalinity, *Ion exchange, *Weathering, *Sulfates, Hydrologic models, Nitrates, Hydrologic budget, Cycling nutrients, Mixing, Ions, Minerals, Chemical reactions, Lake sediments, Path of pollutants, Acid rain, Acidic water, Seepage lakes, Model studies, Biological degradation.

In-lake alkalinity generation (IAG) is important in regulating alkalinity in lakes that have large water residence times (RT), particularly seepage lakes, which receive most of their water from direct precipitation and thus receive little alkalinity from watershed weathering processes. Major IAG processes include nitrate assimilation, sulfate reduction, and cation production; conversely, ammonium assimilation consumes alkalinity. Nitrate and ammonium are both efficiently retained by lakes with RT $>$ 1 year, and net alkalinity generation by immobilization of these ions depends upon their relative inputs. Ion budgets show that in-lake cation production occurs in some lakes, but the relative importance of possible mechanisms (e.g., cation exchange, mineral weathering, or biological recycling) is not well understood. Sulfate reduction is the dominant IAG process in most seepage lakes, and sulfate is the major acid anion in precipitation. Sulfate reduction does not require an anoxic water column but occurs by diffusion into anoxic sediments. Sulfate retention in acid-sensitive lakes can be predicted by a simple input-output model with a first-order rate constant (k(SO4) is equivalent to 0.5 m/year). Further research is needed to assess the relative importance of sestonic sulfur deposition and dissimilatory reduction, to determine environmental factors that control reduction rates, and to determine the extent of recycling. Techniques used to measure IAG processes are described, and limitations of each method are discussed. (See also W88-09065) (Author's abstract)
W88-09074

FATE OF SOME CHLOROBENZENES FROM THE NIAGARA RIVER IN LAKE ONTARIO,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
For primary bibliographic entry see Field 5B.
W88-09079

PESTICIDES: MINIMIZING THE RISKS.
American Chemical Society, Washington, DC. ACS Symposium Series 336. Developed from a symposium sponsored by the Division of Agrochemicals at the 191st Meeting of the American Chemical Society, New York, NY, April 13-18, 1986. 1987. Edited by Nancy N. Ragsdale and Ronald J. Kuhr. 183 p.

Descriptors: *Pesticides, *Pesticide residues, *Risks, *Water pollution effects, *Pesticide toxicity, *Pesticide drift, Models, Fate of pollutants, Water pollution sources, Path of pollutants, Hazardous wastes, Waste disposal, Public health, Pesticide kinetics, Metabolism, Biotransformation.

The effects of pesticides on human health and the environment have increased public concern in the past three decades. A substantial legislative background based on risk assessment and management exists for regulation of these chemicals to protect the environment and human safety. This 14-chapter book examines technological developments designed to aid the risk assessment process in sections covering toxicology, pests, chemicals, and potential hazards. Specific topics deal with toxicity testing requirements for pesticide registration, acute and chronic toxicity, simulation modeling in toxicology, environmental mobility principles, public education concerning risks, the effect of mass media on public perceptions, and pests as part of the ecosystem. This book also highlights problem areas, identifies information needs, and provides new ways to look at problems associated with pesticide risks. It is intended to help biologists, toxicologists, agricultural chemists, and environmental scientists, as well as any students involved in these disciplines. (See also W88-09083) (Geiger-PTT)
W88-09082

TOXICOLOGICAL AND EPIDEMIOLOGICAL EFFECTS OF PESTICIDE CONTAMINATION IN CALIFORNIA GROUND WATER.
California Dept. of Health Services, Berkeley.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 423-435, 1 fig, 1 tab, 29 ref.

Descriptors: *Pesticides, *Water pollution effects, *Groundwater pollution, *Toxicology, *Epidemiology, *Carbamate pesticides, Toxicity, Carcinogens, California, Aldicarb, DBCP, Ethylene dibromide, Fumigants.

The contamination of California groundwater by pesticides is a problem which is becoming more evident as monitoring programs are implemented. In a recent study 54 pesticides were detected in 2,893 wells in the State. Among the most pervasive toxic chemicals found were 1,2-dibromo-3-chloropropane (DBCP), ethylene dibromide (EDB) and 1,2-dichloropropane (1,2-D). DBCP alone resulted in the closure of about 1000 drinking water wells. Toxicological evidence from animal studies indicates that these substances are carcinogenic and in one epidemiological study there was an excess of stomach cancer in census tracts with high DBCP content. An acutely toxic chemical, aldicarb, was also detected in a number of wells in the State. Adverse reproductive effects and neurotoxicity occur with several of these pesticides. (See also W88-09089) (Author's abstract)
W88-09111

USES OF ENVIRONMENTAL TESTING IN HUMAN HEALTH RISK ASSESSMENT,
Centers for Disease Control, Atlanta, GA.
For primary bibliographic entry see Field 7A.
W88-09122

LABORATORY APPROACH FOR DETERMINING THE EFFECT OF OILS AND DISPERSANTS ON MANGROVES,
Research Planning Inst., Inc., Columbia, SC.
C. D. Getter, and B. J. Baca.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 5-13, 4 fig, 2 tab, 10 ref.

Descriptors: *Water pollution effects, *Oil pollution, *Dispersants, *Mangroves, Estuaries, Toxicity, Oil spills, Aquatic vegetation, Leaves, Seedlings, Lethal limits, Toxicity.

An experimental approach was developed for testing the effects of oil and dispersant combinations on the growth of mangrove seedlings (trees of the intertidal tropics). Preliminary test results are reported for two species of mangroves collected from five localities, including both oiled and unoiled estuaries. Avicennia germinans (L.) L. (black mangrove) was more sensitive than Rhizophora mangle L. (red mangrove) when exposed to almost all substances tested. Light Arabian crude oil (LA) and light Arabian crude oil dispersed (LAD) were the most toxic substances tested. No. 2 fuel oil (N2) and No.2 fuel oil dispersed (N2D) were as toxic as LA and LAD, except for an increase (an enhancement effect) in foliage and stem growth in Avicennia at lower dosages. Bunker C oil (9BC) was the least toxic of the oils tested, resulting in the reduction of foliage and stem growth only at the highest dosage tested in Avicennia. Bunker C oil dispersed (BCD) failed to show effects in either species at any dosage tested. The leaves of Rhizophora were the most sensitive part of the plant tested. Root-dosing had a lesser effect than leaf-dosing but resulted in greater effects with LAD than with any other substance tested. Seedling stock from chronically oiled areas sprouted more rapidly and developed more foliage in response to LA, indicating a possible 'preadaptation' to spilled oil; no such effect occurred when dispersant was added to LA. The response of mangroves was specific to the oil type to which the dispersant was added. Dispersant increased the toxicity of LA and N2 but decreased the toxicity of BC. (See also W88-09183) (Author's abstract)
W88-09184

TOXICITY TESTING WITH CONSTANT OR DECREASING CONCENTRATIONS OF CHEMICALLY DISPERSED OIL,
Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.
J. W. Anderson, S. L. Kiesser, D. L. McQuerry, R. G. Riley, and M. L. Fleischmann.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 14-22, 2 fig, 2 tab, 9 ref. American Petroleum Inst. Contract no. 2311203641.

Descriptors: *Toxicity, *Oil pollution, *Dispersants, *Water pollution effects, Lethal limits, Oil,

Marine environment, Shrimp, Seasonal variation, Chemical treatment.

An exposure system and method of quantifying toxicity were developed to provide an estimate of the effects of dispersed oil on marine organisms under a variety of exposure conditions. Results of constant concentration exposures (for hours or days) can be compared to those of diluting exposures (decreasing to zero in 8 or 24 hr) on a basis of the 'toxicity index.' This index is equal to the total exposure when time in hours or days is multiplied by the concentration at each hour (ppm/hr) or ppm/d). Tests have been conducted with shrimp (Pandulus danae), two oils (Prudhoe Bay crude and a light Arabian crude), and two dispersants. There is a seasonal pattern to the tolerance of the shrimp. Tests in the colder months (fall/winter) produce toxicity indices approximately three times higher than summer/spring values. In tests of shrimp with Prudhoe Bay crude oil and a chemical dispersant during the fall/winter season, constant and 24-hr dilution exposures produced toxicity indices of 11 (+ or - standard error) and 10 (+ or - 0.6 standard error) ppm/days were found respectively. During the fall/winter season (greatest tolerance), tests with Prudhoe Bay crude and two different chemical dispersant produced toxicity indices for P. danae of 10 (+ or - 0.6) and 12 (+ or - 1.1) ppm/d. During tests in summer, there was also little difference observed when the toxicity of the light Arabian oil was compared to that of Prudhoe Bay crude (2.3 and 3.4 ppm/d, respectively). Using these methods it is possible to predict the outcome of dispersant application under varying environmental conditions. (See also W88-09183) (Author's abstract)
W88-09185

UNIFORM METHODS FOR EXPOSURE REGIMES IN AQUATIC TOXICOLOGY EXPERIMENTS WITH CHEMICALLY DISPERSED OILS,
Department of the Environment, Ottawa (Ontario).
P. G. Wells, J. W. Anderson, and D. Mackay.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 23-37, 2 fig, 2 tab, 63 ref.

Descriptors: *Toxicity, *Dispersants, *Oil pollution, Chemical treatment, Water pollution treatment, Marine environment, Aquatic environment, Chemical analysis, Oil, Sediments.

Many different approaches have been used recently in aquatic toxicity research for preparing and analyzing test solutions and dispersions of hydrocarbons, dispersants, hydrocarbon/dispersant mixtures, and oiled sediment mixtures. This variety is a result of the novelty of this research field. Therefore, much of the published work is difficult to compare, summarize, and interpret. Both uniform and unique methods will contribute to a better understanding of the toxicology and potential field effects of chemically dispersed oils in marine waters. Some current methods, and recommendations for the adoption of certain principles and uniform methods for water and sediment studies are summarized. Specific items discussed are: (1) choice of oils and dispersants; (2) degree of 'weathering' of the experimental oils; (3) preparation of water soluble fractions and oil dispersions in water; (4) choice of dispersant/oil ratios, especially considering dispersant effectiveness; (5) reagent mixing and premixing; (6) dosing of sediments; (7) chemical analysis of dispersed hydrocarbons; and (8) choice of exposure concentrations, composition, and durations. (See also W88-09183) (Author's abstract)
W88-09186

TOXICITY OF OIL SPILL DISPERSANTS TO MARINE ORGANISMS: A CURRENT PERSPECTIVE,
Department of the Environment, Ottawa (Ontario).
P. G. Wells.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 177-202, 2 fig, 12 tab, 141 ref.

Descriptors: *Toxicity, *Water pollution effects, *Oil spills, *Marine environment, Lethal limits, Surfactants, Shrimp, Zooplankton, Copepods, Oil pollution, Oil.

The toxicity of second-generation dispersants and component surfactants to a wide range of marine organisms is reviewed. A current perspective on oil spill dispersant toxicology is presented. Known lethal and sublethal thresholds are summarized for various dispersants (concentrated, water-immiscible, water-miscible). Existing information on the comparative toxicology of surfactants and dispersants is evaluated; the data base on a current formulation (Corexit 9527) is thoroughly examined. Current laboratory studies with brine shrimp and endemic marine copepods are briefly described. Factors known to influence the toxicity of dispersants are described. The sites and physiology of toxic action of dispersants, though incompletely understood, are discussed; respiratory and nervous systems appear to be primary targets of action. Hypothesized relationships between dispersant toxicity and effectiveness, and the toxicity of chemically dispersed oil are discussed. (See also W88-09183) (Author's abstract)
W88-09197

COMPARISON OF THE FATE AND ECOLOGICAL EFFECTS OF DISPERSED AND NONDISPERSED OIL IN A VARIETY OF INTERTIDAL HABITATS,
Field Studies Council, Pembroke (Wales). Oil Pollution Research Unit.
For primary bibliographic entry see Field 5B.
W88-09200

EFFECTS OF TEST SPILLS OF CHEMICALLY DISPERSED AND NONDISPERSED OIL ON THE ACTIVITY OF ASPARTATE AMINOTRANSFERASE AND GLUCOSE-6-PHOSPHATE DEHYDROGENASE IN TWO INTERTIDAL BIVALVES, MYA ARENARIA AND MYTILUS EDULIS,
Bowdoin Coll., Brunswick, ME. Marine Research Lab.
E. S. Gilfillan, D. S. Page, S. A. Hanson, J. Foster, and J. Hotham.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 299-313, 7 fig, 1 tab, 16 ref.

Descriptors: *Water pollution effects, *Oil spills, *Dispersants, *Mollusks, *Water pollution treatment, *Path of pollutants, Chemical treatment, Littoral zone, Mytilus edulis, Mya arenaria, Oil pollution, Bioaccumulation, Physiology, Enzymes, Intertidal areas, Sediments.

In 1981, two test oil spills were made in Maine. One spill was 975 L (250 gal) of Murban crude oil; the other was 975 L of Murban crude oil premixed with 97 L (25 gal) of Corexit 9527. The uptake of the oil and its effects on enzymatic activity in two species of common intertidal bivalve mollusks, Mya arenaria and Mytilus edulis, were studied. Data were obtained on uptake and depuration of the oil for each species; data were also obtained on the activity of glucose-6-phosphate dehydrogenase and aspartate aminotransferase for each species. Data were collected both before and after each of the spills. Much less oil was taken up by the animals exposed to chemically dispersed oil than by those exposed to nondispersed oil. Rates of depuration were the same for each species; they were also the same regardless of oil exposure. The results show that a cloud of dispersed oil released in 3 m of water at high water slack with violent mixing had only a transitory effect on two enzyme systems of two filter-feeding bivalves. The same volume of untreated oil during a falling tide on a similar shore containing the same animals had much more severe and long-lasting effects because of the much greater persistence of oil in sediments as opposed to the water column. (See also W88-09183) (Lantz-PTT)
W88-09202

TOXICITY OF OIL AND CHEMICALLY DISPERSED OIL TO THE SEAGRASS THALASSIA TESTUDINUM,
Research Planning Inst., Inc., Columbia, SC.
B. J. Baca, and C. D. Getter.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 314-323, 6 fig, 1 tab, 17 ref.

Descriptors: *Toxicity, *Water pollution effects, *Oil spills, *Dispersants, *Sea grasses, Chemical treatment, Thalassia testudinum, Hydrocarbons, Oil pollution, Benzene, Toluene, Lethal limits.

Turtle grass beds are diminishing throughout the tropics because of damage from dredging, boats, and other factors. The toxicity of chemical dispersants and crude oil to turtle grass was determined in the laboratory to assess the potential for damage from spills occurring in the field. Studies of water-soluble fractions (WSF) of crude oil in static bioassays showed that a chemical dispersant (Corexit 9527) increased the amount of total oil in water more than 50-fold. The toxicity of chemically dispersed oil was assessed by conventional (96-h 50% lethal concentration) methods in static systems, and the results were compared with toxicity measurements where the system was flushed after 12 h. Prudhoe Bay crude WSF was more toxic than dispersed oil or dispersant alone, possibly because of the large component of benzene, toluene, and C-2 benzene. The percentage of green (chlorophyllous) leaves was useful as evidence of toxicity. Observations of the symptoms of turtle grass oiling revealed various anatomical features that aid in resistance to toxicity. Turtle grass leaves grow from a meristem hidden at the base of the leaf sheaths. Though protected, this meristem will, without exception, degenerate when the plant is dying. No plants observed have recovered from meristem degeneration, regardless of rhizome length, and the rhizome itself becomes spongy and degenerates. Under lethal concentrations of dispersed oil and dispersant alone, the entire exposed surface of leaves turned brown. Upon elongation of the newest exposed leaf, the emerging area was green, and in some cases, these plants survived by leaf elongation and detachment of brown leaves at the sheath. This points to the importance of the sheath as protection for new leaves, an anatomical feature of many grasses (though turtle grass is not a true grass) used for protection of the growing tissues from grazing. (See also W88-09183) (Lantz-PTT)
W88-09203

ECOLOGICAL CONSIDERATIONS FOR THE USE OF DISPERSANTS IN OIL SPILL RESPONSE,
Atlantic Richfield Co., Los Angeles, CA.
J. Lindstedt-Siva, P. H. Albers, K. W. Fucik, and N. G. Maynard.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 363-377, 95 ref.

Descriptors: Water pollution treatment, *Water pollution effects, *Ecological effects, *Dispersants, *Oil spills, *Cleanup operations, *Standards, Estuaries, Marine environment, Water pollution control, Birds, Oil pollution, Oil, Environmental impact studies.

A multidisciplinary task force with membership from government agencies, academia, and industry is developing ecologically based guidelines for dispersant use in marine and estuarine environments. The guidelines are organized by habitat type (e.g., coral reefs, rocky shores, bird habitats) and consider dispersant use to protect the habitats from impact, to mitigate impacts, and to clean the habitats after a spill. Each guideline contains a description of the habitat type covered, recommendations for dispersant use, and a background section reviewing the relevant literature. The goal is to minimize the ecological impacts of oil spills. Aesthetic, socioeconomic, and political factors are not considered, although it is recognized that these are important concerns during spill response. Use of dispersants is considered along with other appropriate countermeasures and compared with the 'no cleanup' alternative. (See also W88-09183) (Author's abstract)
W88-09206

MATHEMATICAL MODEL FOR PREDICTING THE ECOLOGICAL IMPACT OF TREATED AND UNTREATED OIL SPILLS,
Ross (S.L.) Environmenal Research Ltd., Ottawa (Ontario).
B. K. Trudel.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 390-413, 10 fig, 5 tab, 23 ref.

Descriptors: *Dispersants, *Mathematical models, *Ecological effects, *Oil spills, *Water pollution treatment, Fish, Model studies, Aquatic animals, Water birds, Toxicity, Hydrocarbons, Oil pollution, Chemical treatment, Lethal limits, Computer models, Mortality, Cleanup.

An ecological impact model, designed to estimate the impact of chemically treated and untreated oil spills on seabirds and fish, was developed to aid dispersant-use decision-making. Impact was defined as the proportion of the animal population killed and the length of time required for that population to recover to its prespill condition. Subroutines dealt with the fate of oil, the toxicity of spilled oil, the concentration of organisms at the location of the spill, and the recovery potential of the target population. The model was site-specific. The paper describes briefly the structure and operation of the model, but most of the discussion deals with the modeling of eco-toxicity. The model uses information on oil fate and the sensitivity of organisms to compute the size and location of lethal areas. For fish, the dose of hydrocarbons reaching the organism's tissues is estimated to determine whether this dose is lethal or not. For seabirds, it was assumed that any contact between seabirds and the oil slick would be lethal. The findings suggest that for some situations, chemically dispersed oil might have a greater area of effect and greater environmental impact than undispersed oil. More important, the area of effect of large oil spills, whether treated or not, may be very small relative to the area over which target populations are distributed. Estimates of the size of the zone of lethal conditions made using the exposure dose-response method developed here were similar to those obtained using other methods such as the critical-peak-exposure concentration method and the integrated exposure (Toxicity Index) method. (See also W88-09183) (Author's abstract)
W88-09208

OIL SPILL DISPERSANTS: DOES SOUTH AFRICA HAVE AN ALTERNATIVE,
Sea Fisheries Research Inst., Cape Town (South Africa).
For primary bibliographic entry see Field 5G.
W88-09209

ANNUAL REPORT OF ECOLOGICAL RESEARCH AT THE SAVANNAH RIVER ECOLOGY LABORATORY.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-012054. Price codes: A06 in paper copy, A01 in microfiche. DOE Report SRO--819-17, (1986). 170 p. DOE Contract DE-AC09-76SROO-819, For the Period Ending July 31, 1986. Edited by William D. McCort and Rebecca B. Wolf.

Descriptors: *Water pollution effects, *Savannah River Ecology Laboratory, *Ecological effects, Wetlands, Ecosystems, Stress, Environmental effects, Wildlife, South Carolina.

A laboratory operated by the University of Georgia was established at the U.S. Department of Energy Savannah River Plant. The Savannah River Ecology Laboratory (SREL) has since received international recognition and acclaim, and is now one of the leaders in ecological research in the nation. The laboratory currently operates as a set of three divisions: Biogeochemical Ecology, Wetlands Ecology, and Stress and Wildlife Ecology. Articles in this report present selected research highlights of 1986 in each of these divisions. They are not intended to cover all aspects of current SREL programs. (See W88-09212 thru W88-09234) (Lantz-PTT)
W88-09211

REVEGETATION OF STEEL CREEK DELTA AND CORRIDOR,
For primary bibliographic entry see Field 2H.
W88-09220

SEDIMENT INSTABILITY AND WOODY SEEDLING GROWTH,
K. W. McLeod, and K. C. Sherrod.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 73-77, 1 fig, 1 tab.

Descriptors: *Wetlands, *Thermal pollution, *Water pollution effects, *Trees, *Sediment erosion, *Seedlings, *Plant growth, *Erosion, Sedimentation, Flooding, Cypress, Willow, Buttonbush, Water tupelo, Savannah River Plant.

An impact of thermal effluents that has been largely overlooked is sediment instability. While reaponses to sediment instability, including both erosion and sedimentation, have been documented in field observations, few experimental studies have been undertaken on this topic. Erosion exposes the plant's root system, increasing the potential for windthrow and waterthrow. Sedimentation restricts oxygen flow to the root system by lengthening the flow path. The ability to produce adventitious roots is probably an important characteristic of species successful in tolerating either sedimentation or erosion. Flooding can compound these problems. The objective of this study was to document the growth and biomass responses to flooding, with and without sediment instability, and with and without subsequent flood recession (drawdown), on seedlings of four woody inhabitants of the Savannah River Plant (SRP) swamp system: bald cypress-water tupelo (Taxodium distichum (L.) Richard and Nyssa aquatica L.), black willow (Salix nigra Marshall), and buttonbush (Cephalanthus occidentalis (L.)). Preliminary statistical analyses revealed few differences exist. Simple flooding did not affect the growth of any of these four species. Erosion generally reduced dimensional growth and biomass in buttonbush, water tupelo and black willow, but not in bald cypress. Water tupelo showed the greatest susceptibility. All species generally produced greater dimensional growth and biomass as a result of sedimentation. Drawdown following flooding decreased growth if erosion occurred and increased growth if sedimentation occurred. Water tupelo and bald cypress were least negatively affected of the four species by drawdown while eroded, and the most positively affected by drawdown following sedimentation. However, while water tupelo can maintain itself following drawdown while eroded, it suffered the largest reductions of any species due to erosion alone. (See also W88-09211) (Lantz-PTT)
W88-09224

NATURAL VARIATION IN STREAM AND WETLAND ECOSYSTEMS AND THE EFFECTS OF DEFENSE WASTE PROCESSING FACILITY CONSTRUCTION,
J. N. Knox, J. H. K. Pechmann, and D. E. Scott.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 91-96, 3 fig.

Descriptors: *Waste disposal, *Ecosystems, *Stream biota, *Construction, *Water pollution effects, *Wetlands, *Industrial wastes, Hydroperiods, Amphibians, Ponds, Statistical studies, Ecosystems, Growth, Nuclear industry.

In order to assess the impact of the Defense Waste Processing Facility (DWPF) construction on the Sun Bay amphibian community, and the effectiveness of DOE mitigation efforts, amphibians at the following sites were censused daily using drift fences and pitfall traps: Sun Bay proper prior to construction (1979 to June 1982), the Sun Bay area during construction (1983 to present, five months a year), Rainbow Bay (September 1978 to present), Bullfrog Pond (a 30-year old borrow pit, 1980 to 1982), and four artificial refuge ponds (June 1983 to present). All sites except the refuge ponds (which are discussed separately) are ephemeral ponds that fill and dry annually, and can be ranked on a scale of relative pond permanence. In FY-1985 the refuge ponds had begun to show some promise in mitigating the impact on amphibian populations: 2292 juveniles of five species were produced in that year. The breeding success of two species at Rainbow Bay, Sun Bay, and Bullfrog Pond has been related to the number of days the site held water (hydroperiod). In this report the relationship between hydroperiod and amphibian community-level properties are demonstrated, e.g., total juvenile production and species richness of juveniles. The community-level analyses revealed two important trends. First, the breeding success of all species combined is correlated with the number of days a site holds water, and second, there is also a positive relationship between hydroperiod and the number of species that metamorphose from a site. Thus, on a community level, the abiotic factor of hydroperiod exerts a substantial influence on total juvenile amphibian species richness and breeding success. At the species level the pattern is not as clear. Regression analyses indicated that a significant portion of the variance in salamander species' breeding success is explained by hydroperiod ($p < 0.10$ for four of five species). This is not true in anurans, in which hydroperiod was not related to breeding success in any of nine species ($p > 0.10$). (See also W88-09211) (Lantz-PTT)
W88-09227

LARVAL FISH ASSEMBLAGES ALONG REACTOR THERMAL PLUMES IN A RIVERINE SWAMP SYSTEM,
J. M. Aho, and C. S. Anderson.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report No. SRO--819-17, (1986). p 97-103, 4 fig, 1 tab.

Descriptors: *Population dynamics, *Wetlands, *Ecosystems, *Water pollution effects, *Thermal pollution, *Swamps, *Fish, *Larvae, *Nuclear reactors, Industrial wastes, Water temperature, Light, Photoperiod, Rivers, Spawning, Ecological effects, Nuclear industry, Savannah River Plant.

Environmental perturbations in the form of heated effluents and an erratic, fluctuating hydrologic regime allow study of the importance of abiotic factors on reproduction, in resident fishes of the extensive Savannah River Swamp System (SRSS). The points addressed were: (1) Whether elevated water temperature affects the timing and phenology of larval fish recruitment; (2) If species-specific recruitment occurs at identical temperatures or whether fish in unimpacted areas occur at cooler temperatures because of additive photoperiod effects; and (3) Whether reproductive activity and success depend on changes in water level. There is no simple temperature or photoperiod threshold governing reproduction, as timing varied between the habitats and the temperatures of appearance for the common taxa was not similar between sites.

This supports the existence of multiple cues controlling larval recruitment. While temperature and photoperiod are influential, food supply or macrophyte growth, amongst others, could assume joint importance. The altered sequence of larval appearance in the thermal compared with ambient areas, however, suggests reproductive control processes fail under these disturbed conditions. Either species do not receive the proper environmental cues to initiate spawning, or early developmental stages are exposed to stressful conditions. The reduced catch from the thermal area provides evidence for the latter view. The influence of fluctuating environmental conditions is also shown by the variability in assemblage structure between wet and dry years, probably due to availability of suitable habitat for spawning and refuge from predators, and food availability. (See also W88-09211) (Lantz-PTT)
W88-09228

WINTER ACTIVITY AND SURVIVAL OF CROCODILIANS IN THERMALLY ALTERED AND NON-ALTERED ENVIRONMENTS,
R. A. Seigel, L. A. Brandt, and S. S. Novak.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 121-125, 1 fig.

Descriptors: *Water pollution effects, *Thermal pollution, *Alligators, *Animal behavior, *Survival, *Seasonal variation, Nuclear industry, Caimans, Water temperature, Behavior, Animal behavior.

The American alligator population on the Savannah River Plant (SRP) is exposed to much colder winters than occur in most other parts of the species' geographic range. In addition, several populations of alligators on the SRP inhabit areas that are thermally altered, and may show different responses than do alligators in non-altered areas. Information is presented here on two related topics: the annual activity patterns of alligators inhabiting thermally altered and non-altered areas, and the effects of freezing temperatures on the survival and behavior of juvenile alligators. Preliminary data suggest that reactor operations play an important role in controlling the kind, but not the magnitude, of alligator activity. Alligators from both the Hot and North Arms are active all year, although Hot Arm individuals tend to be slightly more active during winter. However, reactor activities appear to play an important role in controlling the types of activity displayed. Based on preliminary data analysis, the time budgets of alligators in the North and Hot Arms might be very different, especially infall, winter and spring. Alligators in the North Arm apparently spend a good portion of their daily activity period basking, probably to raise body temperatures to optimal levels. Conversely, owing to thermal effluents from P-Reactor, alligators in the Hot Arm most likely begin their daily activities with body temperatures at or near optimal, and thus rarely bask. During freezing weather alligators keep the tip of their snout out of the water while extending the rest of their body into deeper and warmer water. A study was conducted to determine whether small alligators could exhibit this 'icing behavior', and to compare the responses of alligators, a temperate species, to those of a tropical crocodilion, the spectacled caiman. Caimans are much less tolerant of low temperatures than are alligators. Unlike alligators, caimans do not exhibit icing behavior and make no attempt to use the water as a heat source. Alligators larger than 0.5 m apparently tolerate freezing conditions better than do smaller individuals, especially young of the year. The smaller animals become frozen under the ice and die. A severe winter may kill many first- and second-year young, owing to their inability to maintain air holes. (Lantz-PTT)
W88-09232

WATER POLLUTION AND FISH PHYSIOLOGY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
A. G. Heath.
CRC Press, Inc., Boca Raton, Florida. 1987. 245 p.

Descriptors: *Fish physiology, *Water pollution effects, *Toxicology, Environmental hypoxia, Hematology, Bioaccumulation, Biotransformation, Water pollution control, Liver, Tissue analysis, Growth, Reproduction, Fish, Lethal limits.

This review begins with a discussion of some concepts which are important in understanding how pollution affects the physiology of aquatic animals, i.e. the relationships between aquatic toxicology and fish physiology, levels of integration, importance of dose and duration of exposure, stress, and toxic mode of action. An analysis of the physiological responses to environmental hypoxia is done early in the book because polluted waters are often lacking in dissolved oxygen and many toxic chemicals at acute concentrations induce an hypoxic condition in fish. Each of the subsequent chapters is generally devoted to a specific physiological process (e.g., osmoregulation, energy metabolism, reproduction). For each of these, it begins with a review of some basic physiology applied to fish and this is then followed by a more detailed discussion of how various pollutants affect these functions. Throughout, the emphasis is on the mechanisms of sublethal effects. The book closes with a critical look at some physiological and biochemical measurements that are, or could be, utilized in work on water pollution control. (Lantz-PTT)
W88-09236

ELEMENTS OF NATURAL ADAPTATION OF NATIVE BACTERIAL MACROCOSMS FOLLOWING ORGANIC CONTAMINATION,
Groundwater Technology, Inc., Chadds Ford, PA.
C. Matson.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 358-365. 21 ref.

Descriptors: *Soil contamination, *Saprophytes, *Adaptation, *Survival, *Macrocosms, *Bacteria, *Water pollution effects, *Groundwater pollution, *Toxicity, Population exposure, Biodegradation, Aquifers, Groundwater.

The natural adaptation of soil saprophytes within the matrix of contaminated soil formations is in many ways analogous to in vitro selection by natural or synthetic inhibition. An acclimated microcosm will follow certain trends, the initial inoculum will regress to a stable surviving population. In the spill or leak situation, analogous results occur. The immediate response is for native saprophytes to perish in toxic disequilibrium and to remain in a numerically reduced state. The surviving populations are then subject to adsorbtive and electromagnetic influences of the immediate soil microcosm. Natural regressions reduce these microbes to fairly dispersed concentrations. The surviving members of any population directly represent the inoculum of the future bioreactor. These survivors tend to find their niche. The adaptation that they possessed in order to survive is inadvertently the very same mechanism which enable them to exhibit superior performance in the degradation scheme. This prerequisite for survival is a method for natural selection of biodegraders. The nature of lethal and sublethal damage to microorganisms is described. (See also W88-09283) (Alexander-PTT)
W88-09313

TOXIC TERROR,
American Council on Science and Health, New York.
For primary bibliographic entry see Field 5B.
W88-09359

TOXICITY OF PESTICIDES TO FISH,
Nagarjuna Univ., Nagarjunanagar (India). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W88-09397

TOXICITY OF PESTICIDES TO FISH,
Nagarjuna Univ., Nagarjunanagar (India). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W88-09398

REHABILITATING DAMAGED ECOSYSTEMS.
Volume I. CRC Press Inc., Boca Raton, Florida. 1988. 192 p. Edited by John Cairns.

Descriptors: *Cleanup operations, *Rehabilitation, *Water pollution effects, *Water pollution control, *Water pollution treatment, Wetlands, Rivers, Streams, Ecological effects, Mine wastes, Slurry ponds, Strip mines, Indiana, California, Illinois, North Dakota, Salt marshes, Ecosystems, West Germany.

Future management options for the rehabilitation of damaged ecosystems will be dramatically affected by research opportunities in ecosystems that industry is charged with rehabilitating, or in derelict ecosystems where government must accept this responsibility since it is legally impossibie to assign responsibility to an individual or a private institution. The young and rapidly developing field of restoration ecology has evolved to a sufficient degree to enable cost-effective and ecologically interesting restoration of ecosystems damaged by mining and other anthropogenic activities. It is important for research investigators, regulators, industries, and other organizations charged with rehabilitation to realize that they have a common interest but that all will have to adjust to the needs of the others in order to achieve the desired results. These desired results should be: (1) a cost-effective means of fulfilling the responsibility of rehabilitating the damaged ecosystems so that those charged with this responsibility meet the legal requirements for doing so; (2) the regulators must be able to demonstrate that they have fulfilled their responsibility to the public and to their superiors in the government at whatever level of government they represent; and (3) the research investigators must derive sufficient new information to justify publication in a peer-reviewed scholarly journal. This volume addresses these research needs with chapters discussing: (1) synthetic approaches to ecological research; (2) river and stream restoration; (3) abandoned mines in Illinois and North Dakota: toward an understanding of revegetation; (4) reclamation and treatment of contaminated land; (5) techniques for the creation of wetland habitat in coal slurry ponds; (6) evaluation of strip pits and ponds for physical manipulation to increase wetlands and improve habitat in southwestern Indiana; (7) salt marsh restoration: lessons from California; (8) restoration and management of ecosystems for nature conservation in West Germany. (See W88-09449 thru W88-09458) (Lantz-PTT)
W88-09448

REHABILITATING DAMAGED ECOSYSTEMS.
For primary bibliographic entry see Field 5G.
W88-09457

COMPARATIVE VULNERABILITY TO OIL SPILLS OF BEDROCK VERSUS SAND AND GRAVEL AQUIFERS,
Maine Dept. of Environmental Protection, Augusta.
P. Garrett.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 773-783, 3 fig, 4 tab, 11 ref.

Descriptors: *Groundwater pollution, *Oil spills, *Permeability, *Bedrock, *Aquifer characteristics, Sand aquifers, Path of pollutants, Porosity, Leakage, Sand.

Most hydrogeologists have assumed that the high permeability of sand and gravel deposits makes them most vulnerable to contamination, and thus in need of the greatest levels of protection. Evidence from Maine shows that fractured bedrock aquifers are more vulnerable. In this study of the 33 best-documented spills in Maine, only 5 did not contaminate drilled wells in the bedrock aquifer. In

most cases, this was because there were no local drilled wells, or because the bedrock was protected by thick surficial deposits. Statewide, the contamination of drilled wells by leaked petroleum is disproportionately high. Furthermore, only a few gallons or tens of gallons of petroleum product leaking into the bedrock aquifer can cause a large volume of the aquifer to be contaminated by dissolved components. This is in contrast to the situation in sand and gravel deposits, into which thousands of gallons of product can leak before neighboring sand-point or dug wells are affected. Pumping wells in the bedrock aquifer are especially liable to contamination, because dissolved contaminants are drawn towards them even though they may not be located downgradient of the spill site. But interconnectedness of fractures determines which wells get hit. The geological explanation for all the above phenomena lies with the low porosity of the fractured bedrock aquifer. Low porosity causes greater seepage velocities towards pumping wells, as well as greater distances of travel for water used in such wells. Low porosity also accounts for the smaller volume of spilled product that the aquifer can hold in storage, and which can be recovered from it. Policy recommendations arising from these findings are that the fractured bedrock aquifer deserves the greatest levels of protection. Indices of groundwater pollution potential, such as DRASTIC, should be revised to give higher relative scores to areas of shallow fractured bedrock if their objective is to protect all groundwater from contamination. (See also W88-09477) (Author's abstract)
W88-09520

ZONATION OF MAYFLY NYMPHS AND CADDISFLY LARVAE IN THE ST. MARYS RIVER,
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
D. W. Schloesser.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 227-233, 1988. 2 fig, 3 tab, 23 ref.

Descriptors: *Water pollution effects, *Lakes, *Aquatic insects, Insects, Mayflies, Caddisflies, St. Marys River, Benthic fauna, Industrial wastes, Great Lakes, Larval growth stage.

Sampling of benthos at 166 stations in the lower two-thirds of the St. Marys River in 1974 and 1975 yielded a total of 9 mayfly and 20 caddisfly genera. Densities of mayflies (primarily the pollution sensitive Hexagenia) ranged from 0 to more than 2000/sq m and caddisflies (primarily Polycentropus) from 0 to 744 per sq m in individual samples. No mayflies were collected in a 20 km section of the river extending from below Sault Ste. Marie, Ontario, to the head of Lake George, an area previously identified by the International Joint Commission as having been degraded by industrial wastes. In three sections of the river progressively farther downstream from the degraded section, the average numbers of mayfly nymphs increased from 36 to 264 to 457 per sq m; and in three other nondegraded sections of the river, the range was 127 to 341 per sq m. Densities of caddisfly larvae were low (4 per sq m) in the degraded section of the river that was devoid of mayflies and ranged from 7 to 101 sq m in nondegraded sections. Average densities for all stations combined were 220 sq m for mayflies and 34 per sq m for caddisflies. (Author's abstract)
W88-09556

ANALYSIS AND FATE OF DIBENZOTHIOPHENE DERIVATIVES IN THE MARINE ENVIRONMENT,
Centre National de la Recherche Scientifique, Brest (France). Lab. de Chromatographie.
For primary bibliographic entry see Field 5B.
W88-09568

FOREST DAMAGE: CHARACTERIZATION OF SPRUCE NEEDLES BY PYROLYSIS FIELD IONIZATION MASS SPECTROMETRY,
Fachhochschule Fresenius, Wiesbaden (Germany, F.R.). Dept. of Trace Analysis.
H. R. Schulten, N. Simmleit, and H. H. Rump.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 3, p 241-264, November 1986. 5 fig, 3 tab, 65 ref. Bundesministerium fur Forschung und Technologie, Bonn-Bad Godesberg Project 0373836.

Descriptors: *Ozone, *Plant pathology, *Spruce trees, *Acid rain, *Water pollution effects, *Air pollution effects, Forest, Gas chromatography, Mass spectrometry.

Needle tips of Norway spruce are investigated by direct probe pyrolysis field ionization mass spectrometry and Curie-point gas chromatography/mass spectrometry. The obtained results are used to characterize the thermally stable plant constituents and major macromolecular structures of spruce needles. The analyses of green, damaged, ozone-fumigated and acidic fog water treated spruce needles reveal the major differences between the different samples. It is shown that ozone-fumigation degrades flavones and the lignin structure whereas acidic precipitation changes the polysaccharides in damaged spruce needles. However, the damage pattern in nature cannot be explained by the patterns of experimentally damaged spruce needles alone. (Author's abstract)
W88-09572

EFFECTS OF ACID PRECIPITATION ON SEDIMENT DOWNCORE PROFILES OF DIATOMS, BACTERIAL DENSITIES AND SULPHUR ISOTOPE RATIOS IN LAKES NORTH OF LAKE SUPERIOR,
McMaster Univ., Hamilton (Ontario). Dept. of Chemistry.
H. G. Thode, M. D. Dickman, and S. S. Rao.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 74, No. 4, p 397-422, February 1987. 6 fig, 7 tab, 57 ref.

Descriptors: *Air pollution effects, *Sulfur dioxide, *Water pollution effects, *Acid rain, *Lakes, *Isotope studies, *Diatoms, Bacteria, Sulfur, Water pollution, Lake sediments, Sediments, Geology, Sulfur isotopes, Bacterial densities.

Lakes with the largest downcore sulfur isotope shifts were those closest to the Algoma Ore Ltd., siderite-iron smelter in Wawa. The bedrock geology of two of the lakes located nearest the smelter (Lakes WW1 and WW2) was composed of carbonate-rich siderites. These lakes failed to acidify even though they were exposed to the highest levels of atmospheric sulfur dioxide (Algoma Ore Ltd. in Wawa releases approximately 180,000 metric tons of sulfur dioxide per year). Those lakes which displayed the highest rates of diatom-inferred acidification during the last fifty years were ones with negligible buffering capacity and carbonate-poor bedrock geology. Enhanced sulfur loading to a lake stimulated the production of its sulfur reducing bacteria which in turn increased the relative concentration of isotopically light sulfur in its sulfur sediments. This was indicated by the large surficial population of sulfur reducing bacteria in lakes receiving large inputs of sulfur. In these lakes, the surface sediments (0-2 cm) revealed a significant ($p<0.05$) shift to isotopically light sulfur as a result of bacterial sulfate reduction. As expected, there was no correlation between the rate of lake acidification and the degree of upcore shift toward isotopically light sulfur. (Author's abstract)
W88-09592

DEVELOPMENT OF THE ROTIFER COMMUNITY STRUCTURE IN LAKE CONSTANCE DURING ITS EUTROPHICATION,
Munich Univ. (Germany, F.R.). Zoologisches Inst.
N. Walz, H. Elster, and M. Mezger.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 74, No. 4, p 452-487, February 1987. 7 fig, 3 tab, 84 ref.

Descriptors: *Water pollution effects, *Eutrophication, *Lakes, *Rotifers, *Aquatic populations, *Species composition, Plankton, Lake Constance, Population dynamics, Limnology, Seasonal variation, Predation, Competition.

In the course of eutrophication of Lake Constance, an increase of the rotifer abundance of more than two orders of magnitude was found. This increase took place between 1920 and 1963 as a direct effect of eutrophication and since that time, no quantitative changes were found. On the other hand, the 1960s changes of plankton structure occurred as indirect consequences of eutrophication by the immigration of Cyclops vicinus and Daphnia galeata. The altered structure manifested itself in a totally different seasonal development for which predatory-prey interactions with Cyclops vicinus and Asplanchna priodonta and competition relationships to Daphnia galeata are responsible. (Author's abstract)
W88-09593

IMPACT OF URBAN POLLUTION ON THE ZOOPLANKTON PART OF A NERITIC SYSTEM (MARSEILLE-CORTIOU) (IMPACT D'UNE POLLUTION URBAINE SUR LA PARTIE ZOOPLANCTONIQUE D'UN SYSTEME NERITIQUE (MARSEILLE-CORTIOU)),
Centre d'Oceanologie de Marseille (France).
R. Arfi, and G. Patriti.
Hydrobiologia HYDRB8, Vol. 144, No. 1, p 11-23, January 9, 1987. 11 fig, 6 tab, 26 ref.

Descriptors: *Water pollution effects, *Environmental effects, *Municipal wastewater, *Plankton, *Zooplankton, *Neritic environment, Outfall sewers, Wastewater outfall, Sampling, Species diversity, Aquatic populations, Population dynamics, Crustaceans, Copepods, Larvae, Seasonal distribution, Trophic level, France, Marseille.

Sewage of Marseilles' main outfall permanently pollutes a large coastal area centered around Cortiou, south of the city. In order to study the impact of that urban pollution on the zooplankton, more than 200 samples were collected between 1977 and 1981, several sampling strategies. Quantitatively, the study area showed rather sparse zooplankton. The more important populations were encountered near Cortiou, the non-perturbed reference point with lowest abundance of organisms. Sampling sites located near the outfall are sometimes azoic. Qualitatively, the observed communities are not characteristic of a heavily polluted environment, but correspond to an impoverished neritic community. In the more polluted area, the community is organized around the copepods Clausocalanus sp., Paracalanus sp., and Oithone helgolandica, and a group of less-important species (Oithona nana and the cladoceran Evadne spinifera). Centropagidae, Coryceidae, Onceidae, but also Chaetognathians, Fritilliarins and the meroplanktonic larvae are more frequently encountered in 'clean' water. Community structure is higher during the cold months than summer. The latter period frequently shows a disorganized zooplankton. In most situations, the copepod Acartia clausi plays a minor role in the structural definition of the communities. The variations observed seem largely independent of the parameters reflecting pollution intensity. Stress integration, in relation with the anterior community 'history' (intensity of contact with polluted water, trophic potential of the area) seem to be the main regulator factors. (Author's abstract)
W88-09620

EFFECTS OF EXPERIMENTAL ACIDIFICATION ON A LOTIC MACROINVERTEBRATE COMMUNITY,
Laval Univ., Quebec. Dept. de Biologie.
M. Allard, and G. Moreau.
Hydrobiologia HYDRB8, Vol. 144, No. 1, p 37-49, January 9, 1987. 4 fig, 6 tab, 46 ref.

Descriptors: *Water pollution effects, *Acid rain, *Stream biota, *Acid streams, *Acidic water, *Lotic environment, *Macroinvertebrates, *Ecosystems, Experimental design, Substrates, Benthos, Aluminum, Chemical properties, Species composition, Species diversity, Population density, Aquatic insects, Oligochaetes, Nematodes, Hydrogen ion concentration, Animal physiology.

Numerous studies have been performed to assess the effects of acidic precipitation on benthic invertebrates; unfortunately, these investigations have often produced conflicting results. Considering

this, a study was conducted to assess, in controlled conditions the effects and mechanisms of acidification upon the benthic community. A three-month experimental acidification was carried out on lotic bottom communities under semi-natural conditions in plasticized wooden channels. Acidified communities (pH 4.0), with or without added aluminum, were compared with a reference community (pH 6.3-6.9). Added aluminum concentrations were 0.2 and 0.4 mg per l. Water chemistry and taxonomic composition of the macroinvertebrate communities were monitored. Under acidified conditions, results were similar, with or without added aluminum. Mean abundances of all groups of organisms were lowered. Mayflies nearly completely disappeared from the acidified channels. The only organism not affected by the acidification was Microtendipes sp. Differences in the organism response were observed: Orthocladiinae and Ephemeroptera, especially early instars, were very sensitive to low pH; Chironomini and Tanypodinae were much less sensitive; while Tanytarsini were intermediate. Oligochaeta and Nematoda were difficult to classify, their response being different from one year to another. Organisms inhabiting the surface of artificial substrates disappeared very rapidly from the system, while those buried inside had a delayed reaction to acidification. Aluminum, which was mainly in the monomeric form, was not responsible for community modifications. Direct action of hydrogen ions through a physiological stress seems a more credible explanation. These results, induced by a continuous experimental acidification, suggest that if this small headwater stream undergoes acidification, the resulting invertebrate community will be very simplified, with only resistant species able to cope with the acid conditions. (Author's abstract)
W88-09622

INVESTIGATION OF A TOXIC WATER-BLOOM OF MICROCYSTIS AERUGINOSA (CYANOPHYCEAE) IN LAKE AKERSVATN, NORWAY,

Norges Veterinaerhoegskole, Oslo. Dept. of Food Hygiene.
K. Berg, W. W. Carmichael, O. M. Skulberg, C. Benestad, and B. Underdal.
Hydrobiologia HYDRB8, Vol. 144, No. 2, p 97-103, January 20, 1987. 5 fig, 2 tab, 15 ref. USAMRDC Contract DAMD-17-83-C-4156.

Descriptors: *Limnology, *Water pollution effects, *Lakes, *Eutrophic Lakes, *Drinking water, *Algae, *Cyanophyta, *Microcystis, *Toxins, Toxicity, Eutrophication, Norway, Reservoirs, Bioassay, Chromatography, Peptides, Spatial distribution, Temporal distribution, Chemical properties, Municipal water, Water supply.

During the summer and fall of 1984 and 1985, the eutrophic Lake Akersvatn in southeastern Norway, used as a reserve drinking-water reservoir, was found to produce heavy water blooms of the colonial blue-green alga Microcystis aeruginosa. Samples of the water bloom were found to be toxic using the mouse bioassay. No toxin was found free in the water as detected by HPLC and mouse bioassay. The toxic cells (minimum lethal dose 8-15 mg/kg body weight in mice) and purified toxin (minimum lethal dose 50 micrograms/kg body weight in mice) showed signs of poisoning in laboratory rats and mice identical to that of other hepatotoxin-producing M. aeruginosa blooms and strains reported from other parts of the world. The toxin has chemical properties similar to the cyclic heptapeptide reported for a South African M. aeruginosa toxin. The toxin from Lake Akersvatn bloom material has a molecular weight of 994. The toxic bloom of M. aeruginosa persisted from August to November in 1984 and reappeared in July of 1985. While water from Lake Akersvatn was not used for municipal water supply during this period, the presence of toxic blue-green algae in a drinking water reservoir indicates the need to develop monitoring and detection methods for toxic cells and toxins. (Author's abstract)
W88-09625

AQUATIC OLIGOCHAETA IN SOME TRIBUTARIES OF THE RIO DE LA PLATA, BUENOS AIRES, ARGENTINA,

Universidad Nacional de La Plata (Argentina). Inst. de Embriologia.
C. Gluzman de Pascar.
Hydrobiologia HYDRB8, Vol. 144, No. 2, p 125-130, January 20, 1987. 6 fig, 1 tab, 25 ref.

Descriptors: *Water pollution effects, *Bioindicators, *Stream biota, *Aquatic animals, *Oligochaetes, Streams, Tributaries, Rio de la Plata, Argentina, Domestic wastes, Industrial wastes, Pulp wastes, Food processing wastes, Sediments, Species composition, Tubificids, Tropical regions, Morphology.

Buenos Aires Province has a rich net of rivers and a number of streams which are tributaries of the Rio de la Plata; yet, previous studies of the freshwater oligochaeta of Argentina deal with the Northeast and other isolated geographic areas of the country and there is no knowledge on the rest of Argentina. The oligochaeta of eleven streams flowing into the Rio de la Plata were investigated. One, El Gato stream, is heavily polluted by domestic sewage, cellulose waste from a paper industry, and oil subproducts from large steel works; in another, Rodriguez stream, a cold-storage house causes pollution. The littoral sediments were sampled bimonthly from November 1983 to June 1985; in the laboratory, living specimens were sorted at 10x magnification and fixed in 5% formalin. Twenty-nine taxa (twenty-four naidids, five tubificids) were identified. Most species are cosmopolitan, but Dero evelinae, Pristina leidyi, Slavina isochaeta, and Bothrioneurum sp. are neotropical. Bratislavia unidentata, Haemonais waldvogeli, and Nais pardalis are reported for the first time in Argentina. Variants occur in the shape of the distal end of the penial sheaths of Limnodrilus hoffmeisteri. The dominant Naidid genera are Dero and Pristina. In the polluted El Gato stream only L. hoffmeisteri and L. claparedeianus were found. (Shidler-PTT)
W88-09626

PRIMARY PRODUCTION AND PIGMENTS IN THREE LOW ALKALINITY CONNECTED RESERVOIRS RECEIVING MINE WASTES,

Instituto Nacional de Investigacao des Pescas, Lisbon (Portugal).
G. Cabecadas, and M. J. Bogueira.
Hydrobiologia HYDRB8, Vol. 144, No. 2, p 173-182, January 20, 1987. 6 fig, 5 tab, 25 ref.

Descriptors: *Water pollution effects, *Mine wastes, *Copper, *Reservoirs, *Primary productivity, Pigments, Chlorophyll, Alkalinity, Portugal, Chlorophyll a, Tungsten, Pyrite, Phytoplankton, Biomass, Photosynthesis, Ecosystems, Sediments, Carbon, Respiration, Phosphorus, Limiting factors.

A comparative study of primary production and pigments, conducted from April 1981 to April 1982, in a chain of three low-alkalinity reservoirs situated in northern Portugal revealed significantly lower levels of chlorophyll (159 mg carbon/square m/d and 19.8 mg/square m as chlorophyll a, growing season means) in the reservoir receiving wastes rich in copper from a tungsten-copper-pyrite mine. This contrasts especially with the situation observed in the upstream reservoir which presents the highest values (409 mg C/square m/d and 55.2 mg/square m) recorded in the system. Eventual effects of the mine discharge on phytoplankton biomass and photosynthesis, such as high turbidity and copper toxicity, are discussed. The results indicate that the presence of copper is responsible for the alterations in the phytoplankton community. The lakes exhibit similar photosynthetic capacity, indicating an adaptation to the relatively high copper concentrations in water and sediments. Experiments carried out in the largest unpolluted reservoir show that the loss of carbon through respiration is of major importance and they also indicate that phosphorus is one of the factors limiting phytoplankton productivity. (Author's abstract)
W88-09627

REGULATION OF BLUE-GREEN ALGAL BUOYANCY AND BLOOM FORMATION BY LIGHT, INORGANIC NITROGEN, CO2, AND TROPHIC LEVEL INTERACTIONS,

Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W88-09628

IMPACT OF NUTRIENT ENRICHMENT AND ALKALINIZATION ON PERIPHYTON COMMUNITIES IN THE NEW JERSEY PINE BARRENS,

Rutgers - The State Univ., Camden, NJ. Dept. of Biology.
M. D. Morgan.
Hydrobiologia HYDRB8, Vol. 144, No. 3, p 233-241, January 30, 1987. 2 fig, 5 tab, 33 ref.

Descriptors: *Water pollution effects, *Environmental effects, *Nutrients, *Alkalinity, *Aquatic plants, *Epiphytes, *Pine Barrens, Enrichment, Ecosystems, New Jersey, Urban drainage, Agricultural runoff, Stream biota, Watersheds, Hydrogen ion concentration, Nitrates, Species composition, Species diversity.

The impact of residential and agricultural development on stream periphyton communities in the New Jersey Pine Barrens was examined by comparison with communities in undeveloped areas. Watershed disturbance resulted in stream water primarily characterized by greatly elevated pH levels and nitrate concentrations. A total of 53 periphyton species were encountered in bimonthly samples over a one-year period in the three disturbed and three undisturbed study streams. Species richness was significantly greater in the disturbed streams based on three criteria: the average number of species per stream on each sampling occasion (disturbed = 6.3; undisturbed = 4.9), the average number of species per stream for the entire year (disturbed = 19.3; undisturbed = 16.0), and the total number of species found in streams within a type (disturbed = 40; undisturbed = 31). Species composition also changed significantly as the result of disturbance. There appeared to be replacement of species characteristic of undisturbed Pine Barrens streams with species peripheral to the region. The expected effects of both elevated pH and nitrate were consistent with these results. (Author's abstract)
W88-09630

HEALTH EFFECTS OF DRINKING WATER CONTAMINANTS,

American Water Works Association Research Foundation, Denver, CO.
J. B. Mannion.
Journal of the New England Water Works Association JNEWA6, Vol. 102, No. 1, p 6-12, March 1988. 10 refs.

Descriptors: *Water supply, *Water pollution effects, *Regulations, *Public health, *Population exposure, *Drinking water, *Pollutants, Risks, Carcinogens.

In some cases the importance of minute concentrations of chemicals detected in drinking water systems is a highly debatable issue with strong arguments on both sides. The author, who is Deputy Executive Director of the AWW Research Foundation, presents his own opinions and thoughts on some of the problems associated with risk assessment, animal studies, and the 'threshold theory' of carcinogenicity. The questions raised by the paper are important to the industry because the regulatory climate, as indicated by the various rules and regulations, is in large measure a responae to which evidence and philosophy is accepted by the regulators. (Author's abstract)
W88-09643

EFFECT OF CRUDE OIL AND OIL SPILL CHEMICALS ON NITROGEN FIXATION IN THE CYANOBACTERIA NOSTOC SP.,

Alberta Univ., Edmonton.
J. Marowitch, M. R. T. Dale, and J. Hoddinott.
Environmental Pollution, Vol. 51, No. 1, p 75-83, 1988. 4 fig, 1 tab, 18 ref.

Descriptors: *Water pollution effects, *Oil spills, *Oil pollution, *Cleanup operations, *Dispersants, *Nitrogen fixation, *Cyanophyta, *Nostoc, Nitrogen fixing bacteria, Oily water, Oil, Chemical wastes, Oil slicks.

The effects of crude oil and three oil spill dispersants (Corexit 9600, 9550, and 7664) on nitrogenase activity in the cyanobacteria Nostoc sp. were examined. The addition of oil to Nostoc sp. cultures resulted in a catastrophic decline in nitrogenase activity with activity ceasing 7 h after treatment. The addition of a dispersant with the oil did not ameliorate this effect. Cultures exposed to high concentrations of dispersants showed lower rates of nitrogenase activity than untreated cultures. Corexits 9600 and 9550 which both contain a hydrocarbon solvent, formed emulsions when added to the cultures. These reduced the intensity of light reaching the cells. However, it is unlikely that dispersant concentrations of this magnitude would occur in the field. At the lowest concentrations tested, which approximates the manufacturer's recommended application rate, the effects of the dispersant appear to be negligible. (Author's abstract)
W88-09665

POPULATION DYNAMICS AND SECONDARY PRODUCTION IN AN ESTUARINE POPULATION OF CAULLERIELLA CAPUTESOCIS (POLYCHAETA: CIRRATULIDAE),
Lagos Univ. (Nigeria). Dept. of Biological Sciences.
J. A. Oyenekan.
Marine Biology MBIOAJ, Vol. 95, No. 2, p 267-273, July 1987. 6 fig, 1 tab, 16 ref.

Descriptors: *Water pollution effects, *Population dynamics, *Estuarine environment, *Polychaetes, *Secondary productivity, *Caulleriella, *Population density, Silt, Sediments, Copper, Spatial distribution, Spawning, Life history studies.

Between July 1978 and March 1980, the distribution, population dynamics and secondary production of Caulleriella caputesocis St. Joseph, 1864, in Southampton Water, South England, were investigated. The distribution of the polychaete was related to the amount of silt and copper-content of the sediment, the highest densities occurring in sediment containing 60 to 100% silt and less than 50 ppm copper. Breeding occurred at a low level throughout the year, usually when the worms were over one year old, with peak breeding between May and September. C. caputesocis in Southampton Water is monotelic, and oocytes measured 120 to 160 microns in diameter at spawning. Unshed oocytes were resorbed. Annual secondary production varied between 0.01 and 5.90 g C/sq m/yr and the (annual production) : (mean biomass) ratio of the species ranged between 0.84 and 7.09. (Author's abstract)
W88-09666

SEASONAL VARIATION IN MARINE PHYTOPLANKTON AND ICE ALGAE AT A SHALLOW ANTARCTIC COASTAL SITE,
R. A. Perrin, P. Lu, and H. J. Marchant.
Hydrobiologia HYDRB8, Vol. 146, No. 1, p 33-46, March 10, 1987. 18 fig, 4 tab, 37 ref.

Descriptors: *Eutrophication, *Plant populations, *Seasonal variation, *Phytoplankton, *Marine environment, *Algae, *Diatoms, *Ice algae, *Sea ice, Coastal waters, Shallow water, Antarctica, Chlorophyll a, Population density, Species diversity, Species composition.

The phytoplankton population near Davis, Vestfold Hills, Antarctica was monitored throughout 1982. Chlorophyll-a determinations and counts of living cells in both the water column and sea ice demonstrated a marked seasonality in phytoplankton abundance and species composition. From April to October, nanoplanktonic organisms contributed most of the chlorophyll-a in both the sea ice and water column. Blooms of diatoms occurred in May, November and December in the bottom of the sea-ice and in January and February in the water column. Phaeocystis pouchetii was dominant during December in the water column. Large numbers of dead diatoms were found in winter. The concentrations of nitrate, dissolved inorganic phosphate and dissolved silicate increased throughout the year until December, when the concentrations of nitrate and silicate fell sharply, followed a month later by a reduction in phosphate concentration. The diversity of phytoplankton was greatest during the summer months. (Author's abstract)
W88-09668

SENSITIVITY OF ASELLUS AQUATICUS (L.) AND PROASELLUS COXALIS DOLLF. (CRUSTACEA, ISOPODA) TO COPPER,
Naples Univ. (Italy). Dipt. Genetica, Biologia Generale e Molecolare.
M. de Nicola Giudici, L. Migliore, and S. M. Guarino.
Hydrobiologia HYDRB8, Vol. 146, No. 1, p 63-69, March 10, 1987. 3 fig, 5 tab, 16 ref.

Descriptors: *Water pollution effects, *Copper, *Crustaceans, *Isopods, *Toxicity, *Copper sulfate, *Asellus, *Proasellus, Median tolerance limit, Life cycle, Juvenile growth stage, Embryonic growth stage, Larval growth stage, Trace metals.

The effects of copper on the life-cycle of two crustacean isopods, Asellus aquaticus (L.) and Proasellus coxalis Dollf., are studied. The time elapsed from the beginning of the experiment and the death of half the individuals (ST50) indicates that females and males are differently sensitive in comparison with juveniles. The two species do not show differences in sensitivity in the range of 0.01-15 mg/L between adults and juveniles. Very low copper concentrations (0.005 mg/L) are ineffective on adult survival but strongly affect the early stages of life-cycle. From an ecological point of view this differential sensitivity suggests that apparently ineffective environmental contaminations can result in a lowering of species survival and, as a consequence, in an alteration of community structure. (Author's abstract)
W88-09669

INFLUENCE OF LINDANE ON THE RESPIRATORY METABOLISM OF ASELLUS AQUATICUS L.: THE RELATIONSHIP BETWEEN CONCENTRATION AND PERTURBATION, (INFLUENCE DU LINDANE SUR LE METABOLISME RESPIRATOIRE D'ASELLUS AQUATICUS L.: RELATION CONCENTRATION - PERTURBATION),
Paris-11 Univ., Orsay (France). Lab. de Zoologie et d'Ecologie.
S. le Bras.
Hydrobiologia HYDRB8, Vol. 148, No. 2, p 115-122, May 20, 1987. 4 fig, 3 tab, 15 ref.

Descriptors: *Water pollution effects, *Lindane, *Asellus, *Pesticide toxicity, *Isopods, *Oxygen requirements, *Respiration, Metabolism, Poisons, Weight, Polarographic analysis, Correlation analysis.

The respiratory metabolism of Asellus aquaticus L. was investigated after a short-term exposure to lindane poisoning at 15C. After 48 h, oxygen consumption was individually recorded with a polarographic method using a Clark electrode and a Copenhagen radiometer. The average oxygen consumption by poisoned individuals is higher than controls at concentrations lower then 8 micrograms/L, but decreases to become lower than controls at higher dosages. If the metabolism of individuals is expressed as a function of weight, we find no significant correlations between weight and metabolism of poisoned Asellus, as opposed to controls. This result can be explained by the fact that poisoning intensity decreases with body weight at a given insecticide concentration, whereas metabolism increases as a function of weight. As a consequence there is apparently a lack or correlation between weight and metabolism amongst poisoned Asellus at dosages higher than 2 micrograms/L. However, if metabolism is expressed as a metabolic ratio, a good correlation is observed between metabolism and weight of poisoned Asellus, the metabolic perturbation being significant at 4 micrograms/L and higher concentrations. These results prompt us to conclude that, during the initial step of intoxication, an increase of the oxygen consumption occurs under weak poisoning conditions, while higher concentrations of insecticide give rise to a decrease in metabolism. (Author's abstract)
W88-09672

PROTOZOAN COMMUNITIES OF THE FLINT RIVER - LAKE BLACKSHEAR ECOSYSTEM (GEORGIA, USA),
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 2H.
W88-09675

EFFECTS OF LAND USE UPON WATER CHEMISTRY, PARTICULARLY NUTRIENT ENRICHMENT, IN SHALLOW LOWLAND LAKES: COMPARATIVE STUDIES OF THREE LOCHS IN SCOTLAND,
Dundee Univ. (Scotland). Dept. of Biological Sciences.
For primary bibliographic entry see Field 4C.
W88-09679

INFLUENCE OF AGRICULTURAL PRACTICES ON THE BIOCOENOTIC STRUCTURE OF LIMNETIC PHYTOPLANKTON (INFLUENCE DES TRAITEMENTS PHYTOSANITAIRES SUR LES BIOCOENOSES DU PHYTOPLANCTON LIMNIQUE),
Paris-11 Univ., Orsay (France). Lab. de Zoologie et d'Ecologie.
J. Goacolou, and M. Echaubard.
Hydrobiologia HYDRB8, Vol. 148, No. 3, p 269-280, May 30, 1987. 5 fig, 4 tab, 27 ref.

Descriptors: *Water pollution effects, *Pesticides, *Agricultural runoff, *Phytoplankton, *Chlorophyll, *Species diversity, *Ponds, *Farm ponds, Lakes, Biomass, Fertilizers, Chlorophyll a, Comparison studies.

The specific diversity of phytoplankton and chlorophyll concentrations were used as a measure of algal biomass in ponds located in agricultural areas where pesticides and fertilizers are currently used and in natural meadows were pesticide spraying has never occurred. A comparison of the biocoenotic structure of the primary producer in the two types of ponds shows conspicuous differences. Species richness is higher in meadow ponds (25 species) than in agricultural area ponds (10 species). The chlorophyll levels are reduced in agricultural area ponds. These effects could be ascribed to contamination by pesticides. (Author's abstract)
W88-09682

EFFECT OF RAINSTORMS ON HETEROTROPHIC BACTERIAL ACTIVITY IN A HYPERTROPHIC AFRICAN LAKE,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 2H.
W88-09683

MACROZOOBENTHOS OF THREE PENNSYLVANIA LAKES: RESPONSES TO ACIDIFICATION,
Lehigh Univ., Bethlehem, PA. Center for Marine and Environmental Studies.
P. T. Bradt, and M. B. Berg.
Hydrobiologia HYDRB8, Vol. 150, No. 1, p 63-74, May 30, 1987. 3 fig, 7 tab, 63 ref.

Descriptors: *Macrozoobenthos, *Benthic fauna, *Lakes, *Acid rain, *Acidic water, *Water pollution effects, Littoral zone, Aquatic animals, Hydrogen ion concentration, Insects, Midges, Pennsylvania, Amphipods, Mollusks.

The littoral macrozoobenthos (MZB) of three northeastern Pennsylvania lakes was sampled seasonally from summer 1981 until summer 1983, to determine if any changes were occurring in response to acid deposition. In the acidified lake

(total alkalinity < or = 0.0 microequivalents/L) the mean pH decreased from 5.5 in 1981 to 4.2 in 1983. Chironomidae comprised 71.3% of the MZB numbers and 19.6% of the wet weight. Over the study period the wet weight of Chironomidae increased ($p < 0.04$) as did the total numbers of Chironomidae in general ($p < 0.01$) and Tanytarsini ($p < 0.01$) in particular. Total numbers of MZB also increased ($p < 0.02$) in the acidified lake, but there was no significant change in the number of taxa, diversity or total wet weight. In the moderately sensitive lake (total alkalinity 47.4 microequivalents/L, mean pH 6.1) Chironomidae were numerically (43%) dominant but Odonata (18.6%) and Mollusca (12.7%) dominated wet weight. There were no significant changes in the MZB of the moderately sensitive lake over the study period. In the least sensitive lake (total alkalinity 190 microequivalents/L, mean pH 6.6) the Amphipoda (31.3%) and Chironomidae (27.3%) together provided 58.6% of the MZB numbers, and the Mollusca formed 55.1% of wet weight. Wet weight at the least sensitive lake was higher ($p < 0.01$) and there were more Ephemeroptera, Pelecypoda and Gastropoda than at the other two lakes. There were no differences in total numbers, diversity or number of taxa among the three lakes. (Author's abstract)
W88-09687

FISH PREDATION, LAKE ACIDITY AND THE COMPOSITION OF AQUATIC INSECT ASSEMBLAGES,
Canadian Wildlife Service, Ottawa (Ontario).
B. E. Bendell, and D. K. McNicol.
Hydrobiologia HYDRB8, Vol. 150, No. 3, p 193-202, July 30, 1987. 5 fig, 3 tab, 33 ref.

Descriptors: *Acid rain effects, *Predation, *Fish diets, *Lakes, *Acidic water, *Aquatic insects, *Aquatic populations, *Fish food organisms, Population density, Species diversity, Hydrogen ion concentration, Nekton, Ontario.

Aquatic insect assemblages were sampled in 2 sets of 18 small lakes in two regions of northeastern Ontario. Both sets included lakes with and without fish. In the set near Sudbury, fishless lakes were acidic. Using a standardized sweep net procedure, fishless lakes in both areas were found to have a greater abundance and richness of insects than lakes with fish. Irrespective of pH, fishless lakes supported a similar aquatic insect assemblage which was characterized by an abundance of nekton, especially Notonectidae, Corixidae, Graphoderus liberus (Dytiscidae) and Chaoborus americanus (Chaoboridae). Those taxa were typically absent from lakes with fish, which often had a marked abundance of Gerridae. It is concluded that fish predation is the most immediate factor structuring such aquatic insect assemblages, and is responsible for their change coincident with lake acidification. (Author's abstract)
W88-09694

EFFECTS OF SHELLSAND ON WATER QUALITY AND MATURE BROWN TROUT (EFFEKT AV SKJELLSAND PA VANNKVALITET OG KJONNSMODEN AURE),
Fylkesmannen i Vesfold, Miljovernavd, Toensberg (Norway).
For primary bibliographic entry see Field 5G.
W88-09699

BENTHIC ECOLOGY OF LOCH LINNHE AND LOCH EIL, A SEA-LOCH SYSTEM ON THE WEST COAST OF SCOTLAND. V. BIOLOGY OF THE DOMINANT SOFT-BOTTOM EPIFAUNA AND THEIR INTERACTION WITH THE INFAUNA,
Alaska Univ., Fairbanks. Inst. of Marine Science.
H. M. Feder, and T. H. Pearson.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 116, No. 2, p 99-134, April 1988. 3 fig, 12 tab, 61 ref, 2 append.

Descriptors: *Organic loading, *Water pollution effects, *Feeding patterns, *Invertebrates, *Fish, *Population density, Population dynamics, Aquatic populations, Bottom sediments, Nutrients, Polychaetes, Sediments, Industrial wastes, Pulp wastes, Benthic environment, Loch Linnhe, Loch Eil, Distribution patterns, Diets, Predation.

The distribution of epifaunal organisms is related to the relative organic enrichment of sediments before and after pollution of the Loch Linnhe-Eil system by pulp- and paper mill effluent. The diet of six abundant epifaunal invertebrate predators and the dominant fish Gadus morhua in the lochs is presented and related to the distribution of their infaunal prey along a gradient of organic enrichment within the system. It is concluded that under normal conditions predators exploit differing prey spectra but that, as organic enrichment increases, their diets converge on the increasingly predominant polychaete worms. (Author's abstract)
W88-09730

CARDIO-PHYSIOLOGICAL RESPONSES OF SOME SELECTED CLADOCERANS TO THREE COMMON POLLUTANTS,
Poona Univ. (India). Dept. of Zoology.
G. T. Tonapi, and G. Varghese.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 1, p 59-65, July 1987. 3 fig, 1 tab, 12 ref.

Descriptors: *Crustaceans, *Water pollution effects, *Cladocerans, Cardiac rhythm, Animal physiology, Pollutants, Chemical properties, Urea, Phenols, Ammonia, Ponds.

Cardio-physiological responses of three common fresh water cladocerans to three ubiquitous pollutants were studied. Daphnia carinata (King), Moina rectirostris (Leydig) and Simocephalus exspinosus (Degeer) were exposed to three toxicants, urea, phenol and ammonia. The physicochemical properties of the pond water from where these animals were collected were also studied. The normal heart beats and heart beats after exposure to the pollutants of both the sexes were recorded kymographically using a lever activated tracer connected to a hair-line ocular micrometer. Each species has its characteristic cardiac rhythm. An average of fifty observations showed that D. carinata is more susceptible to all three pollutants than the other two species. (Author's abstract)
W88-09749

RESPONSE OF THE PHYTOPLANKTON COMMUNITY TO WEEKLY ADDITIONS OF MONOAMMONIUM PHOSPHATE IN A DYSTROPHIC LAKE,
Waterloo Univ. (Ontario). Dept. of Biology.
P. Chow-Fraser, and H. C. Duthie.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 1, p 67-82, July 1987. 5 fig, 6 tab, 33 ref.

Descriptors: *Phytoplankton, *Water pollution effects, *Phosphates, *Trophic level, *Limnology, *Chemical properties, Monoammonium phosphate, Nutrients, Growth, Chlorophyll a, Biomass, Aquatic plants, Dystrophic lakes, Fertilizers.

A dystrophic basin was enriched with low-level weekly additions of monoammonium phosphate over a two year period and the measured summer average chlorophyll a concentrations obtained during the pre- and post-fertilization periods were compared with values predicted from documented relationships between chlorophyll a and phosphorous loading, fertilizer loading, and total phosphorous concentrations (spring and summer average values). Predicted chlorophyll a was 2 to 6 times higher than measured concentrations. Measured phytoplankton biomass concentrations were 1 to 6 times lower than those predicted from documented total phosphorous concentration-biomass regression equations. There was an inconsistent relationship between biomass and chlorophyll a between years; chlorophyll a was better correlated with the biomass of 8 flagellate species (mostly Cryptomonas) than with biomass of all algal taxa. Of the 48 phytoplankton taxa recorded, the biomass of 17 were statistically higher, and 4 were statistically lower in the fertilized basin when compared to a control basin. Enrichment did not change the species composition of the phytoplankton in the fertilized basin; all species that benefitted from phosphorous additions were already present in the basin prior to fertilization. The species that amassed the greatest increase in biomass was Tabellaria fenestrata. Other taxa that showed an increase were Cryptomonas, Chroomonas, Ochromonas, Chromulina and Peridinium. The biomass of Synedra, Tetraedron, Sclenastrum and Psedokephyrion were statistically lower in the fertilized basin than in the control. (Author's abstract)
W88-09750

STUDIES ON THE ACUTE TOXICITY OF COPPER AND MERCURY ALONE AND IN COMBINATION TO THE COMMON GUPPY POECILIA RETICULATA (PETERS),
Industrial Toxicology Research Centre, Lucknow (India).
B. S. Khangarot, and P. K. Ray.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 2, p 303-314, August 1987. 5 fig, 3 tab, 36 ref.

Descriptors: *Water pollution effects, *Toxicity, *Copper, *Mercury, *Fish, Aquatic animal, Guppies, Animal physiology, Median tolerance limit, Lethal limit.

The acute toxicity of copper and mercury to common guppy, Poecilia reticulata (Peters) was tested in hard water (Hardness-175 ppm as CaCO3) at 28 C. The salts were examined individually and in combinations. In the acute static bioassays, the 96 hr LC50 values and their 95% confidence limits in ppm were 0.986 (0.73-1.33) for Cu and 0.026 (0.019-0.0367) for Hg alone. Mixtures of Cu and Hg were additive in toxicity to common guppy. The Marking Additive Index and range were +0.25 (-0.37 to 1.17) at 48 hr and +0.2 (-0.45 to 1.09) at 24 hr; since ranges overlap did not Cu-Hg mixtures were simply additive in toxicity to fish. In another experiment, concentrations were expressed in toxic units by taking them as proportions of LC50 values. It was found that two toxicants had a simple additive effect. In stronger mixtures (e.g., 2 and 5 toxic units), guppies died faster than would be expected from their resistance to the individual metal. (Author's abstract)
W88-09753

INFLUENCE OF WASTEWATER DISCHARGE ON THE UPTAKE KINETICS OF DISSOLVED ORGANIC MATERIALS BY MICROORGANISMS IN THE FRASER RIVER ESTUARY, BRITISH COLUMBIA,
Tsukuba Univ. (Japan). Inst. of Biological Sciences.
H. Seki, A. Otsuki, Y. Fukuyo, K. V. Stephens, and C. D. Levings.
Archiv fuer Hydrobiologie AHYBA4, Vol. 112, No. 1, p 55-65, March 1988. 2 fig, 2 tab, 26 ref.

Descriptors: *Microorganisms, *Estuaries, *Eutrophication, *Metabolism, *Wastewater disposal, *Water pollution effects, *Environmental effects, *Fraser River Estuary, Bacterioplankton, Path of pollutants, Sedimentation, Silt, Municipal wastes, Organic matter, Estuaries, British Columbia, Comparison studies, Marinas, Kinetics, Trophic level, Cycling nutrients.

The effects of natural silts, marine discharges and organic municipal wastes were studied during summer 1986 in the Fraser River estuary, probably the most disrupted estuary on the west coast of Canada. The uptake kinetics of organic materials were examined. Effects of these pollutants on bacterioplankton kinetics in the Fraser River estuary were compared with those of the Campbell River estuary, east coast of Vancouver Island, where very little organic waste is discharged. Hetertrophic processes exceeded the autotrophic processes and were consistently important in the cycling of nutrients in this estuary. Attached bacteria on numerous silts in the water column were primarily responsible for cycling of organic materials. Turnover rates for dissolved organic matter were as little as a few hours. (Author's abstract)
W88-09767

AMINO ACIDS AS A NITROGEN SOURCE OF GROWTH OF OSCILLATORIA RUBESCENS D. C.: ECOLOGICAL SIGNIFICANCE,
Polish Academy of Sciences, Mikolajki. Inst. of Ecology.
For primary bibliographic entry see Field 2H.
W88-09770

ECOLOGY OF JACARE PEPIRA RIVER BASIN: INFLUENCE OF SOIL AND WATER USE AND EFFLUENT DISCHARGE ON WATER QUALITY (SAO PAULO STATE, BRAZIL) (ECOLOGIA DA BACIA DO RIO JACARE PEPIRA: INFLUENCIA DO USO DO SOLO, DA AGUA E DA DESCARGA DE EFLUENTES SOBRE A QUALIDADE DA AGUA (SAO PAULO, BRASIL)),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
M. H. Maier, M. Takino, and M. Tolentino.
Boletim do Instituto de Pesca, Vol. 13, No. 1, p 153-178, June 1986. 1 fig, 29 tab, 21 ref.

Descriptors: *Ecosystems, *Rivers, *Jacare Pepira River Basin, *Water quality, *Heavy metals, *Industrial wastes, *Domestic wastes, Physicochemical properties, Fate of Pollutants, Sugarcane, Climatology, Temperature, Turbidity, Color, Optical properties, Hydrogen ion concentration, Conductivity, Electrical properties, Alkalinity, Chloride, Silica, Phosphate, Ammonium, Nitrites, Nitrates, Iron, Dissolved oxygen, Magnesium, Manganese, Zinc, Nickel, Chromium, Cadmium, Copper, Lead, Arsenic, Silver, Sodium, Aluminum, Sulfates, Barium, Boron, Calcium, Brazil.

To study the influence of pollutants on the water quality of the Jacare Pepira River (Sao Paulo state, Brazil), the following parameters were measured: air and water temperatures, turbidity, color, pH, electrical conductivity, alkalinity, chloride, hardness, soluble silica, phosphate, ammonium, nitrite, nitrate, total iron, dissolved oxygen, oxygen saturation, magnesium, manganese, ziac, nickel, chromium, cadmium, copper, lead, arsenic, silver, sodium, aluminum, sulfate, barium, boron and calcium. Sampling was carried out near the Discharge of effluent from a sugarcane alcohol refinery and from a sugarcane brandy factory. The sugarcane brandy factory discharges its effluents on Bocaina Stream which also receives the domestic sewage from the city of Bocaina. The measurements were taken monthly during two sugar cane harvests: from July to November in 1979 and 1980. The influence of these discharges on the ecosystem is not significant, permitting conditions close to the natural ones to be maintained. The water composition seems more influenced by the physical environment (climate, rocks and soil) than by human activities. (See W88-09775 thru W88-09776) (Hammond-PTT)
W88-09777

AUTODEPURATION OF RIO GRANDE RESERVOIR (RIACHO GRANDE SP, BRAZIL) MAJOR IONS AND CHLOROPHYLL A (AUTODEPURACAO DA REPRESA RIO GRANDE (RIACHO GRANDE SP, BRASIL) IONS DOMINANTES E CLOROFILA A),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 5B.
W88-09778

PHYTOPLANKTON POPULATION DYNAMICS AND CHEMICAL CHARACTERISTICS OF THE SEDIMENTS OF THE SALIHIYAH RIVER, BASRAH, IRAQ,
University Coll., Cardiff (Wales). Dept. of Plant Science.
S. E. Antoine.
Limnology (Berlin) LMNOA8, Vol. 18, No. 1, p 69-82, September 1987. 2 fig, 4 tab, 45 ref.

Descriptors: *Rivers, *Phytoplankton, *Population dynamics, *Sediments, *Water pollution effects, Chemical composition, Spatial distribution, Temporal distribution, Seasonal variation, Chlorophyll a, Irrigation effects, Seepage, Diatoms, Algae, Biomass, Organic matter, Nutrients, Metals, Nitrates, Phosphates, Calcium, Magnesium, Silica, Salihiyah River, Iraq.

Spatial and temporal fluctuations of the phytoplankton and chemical characteristics of the Salihiyah River were investigated. Primary productivity, chlorophyll-a content and total algal counts showed marked spatial variation. The highest values were usually recorded at Station 2 due to the effect of irrigation effluent disposal and of seepage water which increased the nutritional load of that site. They also showed a definite bimodal temporal fluctuation when 2 maxima were recorded in spring and autumn and a minimum in winter. Productivity and chlorophyll-a values showed a highly significant positive correlation with each other and an insignificant correlation with the total phytoplankton count. Total biomass and all algal phyla, except the Pyrrophyta, showed a significant to highly significant positive correlation with each other, particularly between the total biomass, diatom and green algal populations. This indicates that these two phyla formed the bulk of the total biomass. Several algal species reported in the study area are either indicators of alpha- or beta-mesosaprobity. Therefore, it was suggested that the Salihiyah River can be considered as alpha- to beta-mesosaprobic. Higher organic matter, nutrient and metal contents of the sediments were also recorded at Station 2. Their temporal fluctuations were attributed to the growth periods of benthic algae and rooted macrophytes. Organic matter, NO3-N, PO4-P, Ca and Mg contents showed a highly significant positive correlation with each other. This confirms that the nutritional status of the sediments can be deduced from their organic content. SiO2-Si was insignificantly correlated with the other chemical variables but was highly positively correlated with the algal counts indicating that the SiO2-Si content was determined by the diatom silica content. (Sand-PTT)
W88-09806

NATURAL AND COMPULSORY BIOLOGICAL DRIFT IN A SYSTEM OF MOUNTAIN STREAMS UNDER UREA TOP-DRESSING OF THE WATER CATCHMENT AREAS,
Bulgarian Academy of Sciences, Sofia.
S. Kovachev, and Y. Uzunov.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 269-278, December 1987. 5 fig, 4 tab, 22 ref.

Descriptors: *Streams, *Mountain streams, *Catchment areas, *Urea, ertilizers, *Water pollution effects, *Invertebrates, Ammonium, Biomass drift, Water quality, Water temperature.

The impact of urea top-dressing of water catchment areas on the dynamics of the biological drift was investigated. The urea dressing at a norm of 600 kg/ha created an ammonium concentration of 29 mg/cu dm in the first hours, and after 24 h it dropped to 1-2 mg/cu dm. The diel dynamics in the control stream showed that the number of individuals remained relatively steady and the changes affected only the biomass, i.e. the larger individuals took part in the drift. Contrary to this, in the urea treated (experimental) stream both the number of individuals and the biomass were equally affected and their values were the greatest at the beginning of the experiment. These observations were checked experimentally by simulated fertilization. By using the value 'drift intensity' (quantity of organisms in 100 cu m/h) the rapid reduction of the drift scale was shown to parallel the passing of the concentration wave. Statistical evaluation of the impact of the different factors showed that the joint influence of water quantity and temperature are of the greatest importance for the drift scale, while the dressing factor is of importance for the number of individuals only. The effect of top-dressing is shortlived and easily overcome due to the considerable compensatory potential of the biocenosis. (Sand-PTT)
W88-09807

ASSESSING BIOTIC INTEGRITY OF THE FISH COMMUNITY IN A SMALL ILLINOIS STREAM,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 7B.
W88-09818

ALKALINITY AND MAJOR ION BUDGETS FOR A MASSACHUSETTS RESERVOIR AND WATERSHED,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
K. N. Eshleman, and H. F. Hemond.
Limnology and Oceanography LIOCAH, Vol. 33, No. 2, p 174-185, March 1988. 10 fig, 4 tab, 30 ref.

Descriptors: *Water pollution sources, *Water pollution effects, *Reservoirs, *Watersheds, *Alkalinity, *Ions, *Acid rain, Massachusetts, Forest watersheds, Chemical properties, Ecosystems, Oligotrophic lakes, Seasonal distribution, Bases, Weathering, Cation exchange, Humic acids, Sulfates, Sulfur, Oxidation-reduction potential.

A detailed field study of the major ion and alkalinity budgets of Bickford Reservoir and its forested watershed in Massachusetts was conducted to quantify the hydrochemical response of the ecosystem to acid deposition. Three years of alkalinity data from this oligotrophic reservoir exhibit repeating seasonal variability but no clear trend. The annual acid-base status of the system is predominantly determined by the following terrestrial biogeochemical processes: wet and dry acidic deposition, production of base cations by mineral weathering or cation exchange, biological retention of nitric acid, and production of natural humic substances. Although nitric acid deposition was completely neutralized by biological retention, measured bulk sulfate deposition could account for only about 5% of streamwater sulfate output; dry sulfur deposition estimated from throughfall enrichment accounts for an additional 40%. Monthly budgets show a strong seasonal sulfate sink in summer, but estimation of the magnitude of net biotic sulfate removal is confounded by evidence that the weathering of sulfur-containing minerals is significant. Watershed budgets suggest that increased sulfur deposition may cause a decrease in surface water alkalinity, possibly on an equivalent for equivalent basis, unless sulfate reduction and base cation supply increase accordingly. (Author's abstract)
W88-09844

HYDROGRAPHY AND BUDGET OF DISSOLVED TOTAL NITROGEN AND DISSOLVED OXYGEN IN THE STRATIFIED SEASON IN MIKAWA BAY, JAPAN,
Aichi Prefectural Fisheries Experimental Station, Gamagori (Japan).
T. Suzuki, and Y. Matsukawa.
Journal of the Oceanographical Society of Japan NKGKB4, Vol. 43, No. 1, p 37-48, February 1987. 9 fig, 2 tab, 27 ref.

Descriptors: *Nitrogen, *Coastal waters, *Eutrophication, *Estuaries, *Dissolved oxygen, *Seasonal variation, *Model studies, *Cycling nutrients, *Water currents, *Hydrography, Salinity, Mikawa Bay, Japan, Upwelling, Density stratification.

Distributions of salinity, dissolved total nitrogen (DTN) and dissolved oxygen (DO) were observed once a month throughout a year in Mikawa Bay, one of the most eutrophic bays in Japan. Supply of freshwater, DTN and DO from the land and precipitation was estimated. Hydrography, circulation and transformation of DTN and DO during the stratified period were investigated simultaneously by a two-layered box model analysis dividing the bay into five boxes. The two-layered circulation was confirmed. In the upper layer of the river mouth regions, a high production of particulate organic nitrogen (PON) due to the strong upwelling together with the river inflow was found. On the other hand, in the lower layer of the bay mouth region, a high deposition of PON due to weak upwelling and sometimes downwelling and a high decomposition of PON due to the inflow of DO abundant water were also found. The reason why the eutrophication is more severe in the eastern part than in the north-western part of the bay is discussed. (Author's abstract)
W88-09863

REED DECAY AT LAKE CONSTANCE (UNTERSEE) OBSERVATIONS AND INVESTIGATIONS (DAS SCHILFSTERBEN AM BODENSEE - UNTERSEE BEOBACHTUNGEN, UNTERSUCHUNGEN UND GEGENMASSNAHMEN),
V. R. Schroeder.
Archiv fuer Hydrobiologie Supplement Vol. 76, AHBSA8, No. 1/2, p 53-99, June 1987. 18 fig, 3 tab, 28 ref.

Descriptors: *Water pollution effects, *Lake Constance, *Reeds, *Eutrophication, *Aquatic plants, Population dynamics, Aquatic habitats, Dissolved oxygen, Seasonal variation, Biomass, Climate, Lakes, Limnology.

Eutrophication of the Lake Constance provoked an increase of Phragmites population density and a weakening of stem stability. Both symptoms created the formation of a thicket with reduced water exchange between lake and reed belt. In the same time great masses of filamentous algae, mostly Cladophora glomerata, were formed in the littoral zone, dying in autumn when the lake level falls. Biotests indicate that products of Cladophora decomposition are able to prevent the development of shoots and water uptake of roots as well. These still unknown bioactive substances lose their capability of aeration. Cutting off the stand and removing the material was proposed as a reed saving therapy. The new generation does not suffer etiolment any more and is smaller in shoot length and higher in mechanical stability. Atmospheric conditions (frost, precipitations) and raising lake level carry oxygen into the highly organic sediments. Oxygen registrations in situ show positive results (reduced oxygen depletion, increased microbiological activity under aerobic experimental conditions). Reed restoration cannot be expected in a short times since it must be assumed that the bioactive substances percolated into the deeper layers of the anoxic rhizoshpere. (Author's abstract)
W88-09882

LIMNOLOGICAL FEATURES OF A PUERTO RICAN RESERVOIR,
Center for Energy and Environment Research, Mayaguez, PR.
For primary bibliographic entry see Field 2H.
W88-09885

CYCLOPOID COPEPODS IN MARGINAL HABITATS: ABIOTIC CONTROL OF POPULATION DENSITIES IN ANTHROPOGENIC ACIDIC LAKES,
Oslo Univ. (Norway). Dept. of Biology.
For primary bibliographic entry see Field 5G.
W88-09889

PHYTOPLANKTON COMPOSITION AND DYNAMICS IN THE RIVER MEUSE (BELGIUM),
Facultes Universitaires Notre-Dame de la Paix, Namur (Belgium).Dept. of Biology.
For primary bibliographic entry see Field 2H.
W88-09891

ECOLOGICAL INVESTIGATIONS ON CILIATES IN THE PERIPHYTON OF TWO MOUNTAIN BROOKS POLLUTED BY ORGANIC WASTE WATER (METTMA AND GUTACH/WUTACH, SOUTHERN BLACK FOREST) (OKOLOGISCHE UNTERSUCHUNGEN AN AUFWUCHSCILIATEN ZWEIER ABWASSERBELASTETER GEBIRGSBACHE (METTMA UND GUTACH/WUTACH, SUDSCHWARZWALD)),
Bayerische Landesanstalt fuer Wasserforschung, Wielenbach (Germany, F.R.).
J. Bauer.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 77, No. 1, p 1-37, March 1987. 14 fig, 6 tab, 50 ref.

Descriptors: *Mountain streams, *Wastewater pollution, *Water pollution effects, *Bioindicators, Protozoa, Ecological effects, Biomass, Population exposure, Limnology, Streams, Alpine regions.

From September 1976 to January 1978 ecological investigations were made on ciliates in periphyton biocoenoses of two mountain brooks polluted by different types of waste water. The abiotic conditions of the two mountain brooks were also analyzed. The results should that the influence of the waste water on the periphyton biocoenosis is less important qualitatively than quantitative. The results confirm that ciliates are good indicators for the rhithral zones of streams polluted by organic substances. (Author's abstract)
W88-09893

BIOAVAILABILITY OF CHEMICALS IN WASTE PRODUCTS AND IN POLLUTED SOIL,
MICON Environmental Consultants, Vught (Netherlands).
K. Verschueren, and M. J. Visschers.
Toxicological and Environmental Chemistry TXECBF, Vol. 16, No. 4, p 245-258, 1988. 5 fig, 3 tab, 2 ref.

Descriptors: *Path of pollutants, *Bioavailability, *Coal tars, *Hydrocarbons, *Groundwater pollution, *Environmental effects, *Soil contamination, Risks, Viscosity, Toxicity, Daphnia, Chemical wastes, Profiles.

Environmental effects of complex mixtures of chemicals such as coal tars can be derived from the 'bioavailability' of their key components and toxicity of the 'bioavailable' concentrations. In many environmental studies bioavailability is not taken into account. Effects are related to overall concentrations in samples and not to the 'bioavailable' concentrations. This leads to conflicting data on environmental effects. In this article it is proposed to use viscosity as a qualitative indication of the bioavailability of tarry compounds at polluted sites. Furthermore an approach is proposed to evaluate the risk of available PAH concentrations in groundwater. The degree of groundwater pollution can be made visible by showing the total PAH profile. PAH profiles in groundwater can be presented graphically showing PAHs containing two to six fused rings. The position of the PAH profile relating to the weighting lines defines the overall toxicity of the sample. The weighting lines are derived from quantitative structure-activity relations for the aquatic toxicity of PAHs to Daphnia. (Author's abstract)
W88-09907

COMMON LOON REPRODUCTION AND CHICK FEEDING ON ACIDIFIED LAKES IN THE ADIRONDACK PARK, NEW YORK,
State Univ. of New York, Syracuse. Coll. of Environmental Science and Forestry.
K. E. Parker.
Canadian Journal of Zoology CJZOAG, Vol. 66, No. 4, p 804-810, April 1988. 1 fig, 5 tab, 30 ref.

Descriptors: *Acid water, *Lakes, *Loons, *Reproduction, *Water birds, *Acid rain, *Water pollution effects, Mortality, Immature growth stage, Adirondack Mountains, Diets, New York.

The effects of lake acidification on common loon reproduction were studied on a total of 24 Adirondack lakes from May through August in 1983 and 1984. The lakes ranged in size from 10.5 to 179 ha; pH ranged from 4.65 to 6.77 and alkalinity from -66 to 111 microequivalents/L. Although loons nesting on small, low-pH lakes had a high fledging rate, possibly because of reduced disturbance or predation, no significant relationship ($P > 0.10$) was found between lake acidity status and loon reproductive success. No chick mortality could be attributed to lake acidification, but chicks on low-pH lakes were generally fed prey much smaller or much larger than those normally preferred. A pair nesting on a fishless lake fed aquatic insects to their constantly begging chick, spending two to four times longer feeding the chick compared with loons on lakes with fish. This pair, alternating absences, flew to another lake to feed, and on three occasions returned to the nesting lake carrying a fish. Loons on the low-pH study lakes apparently adapted, at least in the short term, to food resource depletion associated with acidification. Despite this, acidification creates potentially severe feeding problems for chicks by reducing prey diversity and quantity. (Author's abstract)
W88-09908

BREEDING BIOLOGY OF TREE SWALLOWS IN RELATION TO WETLAND ACIDITY,
Canadian Wildlife Service, Ottawa (Ontario).
P. J. Blancher, and D. K. McNicol.
Canadian Journal of Zoology CJZOAG, Vol. 66, No. 4, p 842-849, April 1988. 6 tab, 88 ref.

Descriptors: *Reproduction, *Tree swallows, *Acid water, *Wetlands, *Eggs, *Acid rain, *Hydrogen ion concentration, *Immature growth stage, *Water pollution effects, Dissolved solids, Organic carbon, Diets, Birds.

The breeding biology of tree swallows (Tachycineta bicolor) was studied in relation to the pH, presence or absence of fish, and dissolved organic carbon concentration in 51 wetlands adjacent to nest boxes northeast of Sudbury, Ontario. Wetland pH was positively related to swallow clutch size, the total volume of eggs in a clutch (clutch volume), the number of fledglings per successful nest, and several measures of nestling size and growth. Swallows breeding near wetlands where fish were present laid earlier, but had smaller eggs and clutch volumes and slower growth of primary feathers than swallows breeding near fishless wetlands. Organic carbon concentrations were poorly related to the reproduction of swallows. These results are discussed in relation to possible mechanisms for the effects of wetland acidity on avian reproduction. (Author's abstract)
W88-09909

EFFECTS OF ACID WATER ON SHELLS, EMBRYOS, AND JUVENILE SURVIVAL OF PLANORBELLA TRIVOLVIS (GASTROPODA: PULMONATA): A LABORATORY STUDY,
Oakland Univ., Rochester, MI. Inst. of Biological Sciences.
R. D. Hunter.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 3, p 315-327, June 1988. 4 fig, 3 tab, 26 ref.

Descriptors: *Acid rain effects, *Calcium, *Snails, *Water pollution effects, *Acidic water, *Hydrogen ion concentration, Population exposure, Tissue analysis, Bioindicators, Reproduction, Ecological effects, Bioassay, Survival.

Adults of the freshwater pulmonate snail Planorbella trivolvis were maintained in aquaria at four pH levels of approximately 4.9, 5.9, 6.8 and 7.8. Adult mortality was moderate over 82 days and not related to the magnitude of pH reduction. Decrease in both shell calcium per unit tissue dry weight and shell calcium per unit maximum shell diameter were significantly reduced after 53 days of exposure to acid water such that for mean Ca/mg, pH 4.9 = 5.9 < 6.8 < 7.8 and for mean Ca/mm, pH 4.9 = 5.9 < 6.8 = 7.8. Empty (ashed) shells without a periostracum lost $CaCO_3$ about 4.6 times faster than did shells of live snails with periostracum intact. Fecundity per snail did not differ greatly from one pH treatment to another although at pH 4.9 the embryos developed slowly and showed a high incidence (38.5%) of abnormality compared to embryos reared at pH 7.8 (4.8% abnormality). Juvenile survival at pH 5.1 was poor with 100% mortality by day 43. At pH 6.6 and 7.5, 9 and 15 individuals respectively were alive at day 93, some of which were functional adults laying eggs. These experiments demonstrate that under laboratory conditions acidified natural water causes measurable snail shell erosion in adults, as well as embryonic abnormalities and increased juvenile mortality. Extrapolation to natural populations under stress due to acidification suggests that adult shell erosion, although unlikely to be a direct cause of death, provides an indicator of stress. A more serious threat to snail populations may be recruitment failure due to mortality of eggs and juveniles. (Author's abstract)
W88-09930

AQUATIC MACROPHYTES OUTSIDE THE OLKILUOTO NUCLEAR POWER STATION, WEST COAST OF FINLAND,
Finnish Centre for Radiation and Nuclear Safety, Helsinki.
J. Keskitalo, and E. Ilus.
Annales Botanici Fennici ABOFAQ, Vol. 24, No. 1, p 1-21, 1987. 9 fig, 5 tab, 68 ref.

Descriptors: *Coastal waters, *Estuaries, *Thermal pollution, *Cooling water, *Thermal stress, *Nuclear plant, *Macrophytes, *Temperature effects, *Population dynamics, *Water pollution effects, Species composition, Ecological effects, Limiting nutrients, Biomass, Spatial distribution, Vegetation, Population exposure, Chlorophyta, Finland, Olkiluoto Nuclear Plant, Bothnian Sea.

The effect of thermal discharges on the macrophytes was studied by SCUBA diving and dredging along permanent transects in the discharge area of the Olkiluoto power station in 1975, 1977, 1979 and 1982. Changes in the vegetation were examined with the aid of rank, heterogeneity and similarity values, based on coverages and the species composition. Since the two units of the power station came into use in 1978 and 1980, the main factors affecting the vegetation close to the cooling water outlet have been the temperature increase, the physical stress caused by the strongly flowing water, and a local nutrient supply. In the outer parts of the discharge area the most important factor seems to be the prolongation of the growing season resulting from the absence of ice in winter. Marked changes in the phytobenthos were recorded in the immediate vicinity of the cooling water outlet: Myriophyllum spicatum had formed a dense and stand and most of the earlier species (e.g. charophytes) had disappeared. Other species tolerant of the strong warm water flow were Cladophora glomerata, Enteromorpha ahlneriana, Ectocarpus siliculosus and Potamogeton pectinatus. On some transects, Ruppia cirrhosa and Ceramium tenuicorne had increased. The total plant cover tended to increase and the heterogeneity along the depth gradient to decrease in the vegetation of the discharge area. On the whole, the zonation of the vegetation was weak during the study period. (See also W88-09939 and W88-09942) (Author's abstract)
W88-09938

CARBON FIXATION OF PHYTOPLANKTON SPECIES IN COOLING WATER OF THE OLKILUOTO NUCLEAR POWER STATION, WEST COAST OF FINLAND,
Finnish Centre for Radiation and Nuclear Safety, Helsinki.
J. Keskitalo.
Annales Botanici Fennici ABOFAQ, Vol. 24, No. 1, p 23-34, 1987. 8 fig, 2 tab, 28 ref.

Descriptors: *Coastal waters, *Estuaries, *Nuclear powerplants, *Cooling water, *Phytoplankton, *Thermal stress, *Temperature effects, *Population dynamics, *Population exposure, *Water pollution effects, Species composition, Seasonal variation, Ecological effects, Limiting nutrients, Biomass, Spatial distribution, Vegetation, Finland, Primary productivity, Olkiluoto Nuclear Plant, Diatoms, Bothnian Sea, Flagellaks.

The effect of thermal discharges from the Olkiluoto nuclear power station (Bothnian Sea) on the production of individual phytoplankton species was determined by track autoradiography in 1981-1982. During the early spring phase, in April, the production of the dominant Chaetoceros wighamii was stimulated by passage through the cooling system. In May the phytoplankton biomass was at its highest, but the cell-specific growth rates of the main species had decreased from April and the response to passage through the station was weak. In summer and autumn, the changes in the production of the prevailing flagellates varied. A strong decline in the production after power station entrainment was noted when the temperature of the discharged water reached 30 deg C and Cryptomonas, Pyramimonas and unidentified flagellates were dominant. Production tended to be smaller in the discharged water than in the intake water, when both were incubated at the ambient temperature. Physiological injuries sustained by the cells during entrainment were compensated to some extent by the stimulative effect of the elevated temperatures in the discharge area. The total impact on the production can be beneficial or harmful, depending on the environmental conditions, and the species composition and successional stage of the phytoplankton. (See also W88-09938 and W88-09942) (Author's abstract)
W88-09939

PHYTOPLANKTON IN THE SEA AREA AROUND THE LOVIISA NUCLEAR POWER STATION, SOUTH COAST OF FINLAND,
Finnish Centre for Radiation and Nuclear Safety, Helsinki.
E. Ilus, and J. Keskitalo.
Annales Botanici Fennici ABOFAQ, Vol. 24, No. 1, p 35-61, 1987. 12 fig, 5 tab, 42 ref, append.

Descriptors: *Thermal pollution, *Cooling water, *Thermal stress, *Coastal waters, *Phytoplankton, *Temperature effects, *Water pollution effects, *Aquatic plants, *Plant physiology, Biomass, Chlorophyll a, Cycling nutrients, Population dynamics, Population exposure, Seasonal variation, Eutrophication, Limiting nutrients, Nutrients, Nuclear powerplant, Finland, Species compositon, Salinity, Loviisa Nuclear Power Station.

The effects of thermal discharges on the phytoplankton were studied with the methods of Lorenzen and Utermohl in the Loviisa archipelago in 1971-1982. Throughout the study period, the species composition was typical of oligotrophic areas off the southern Finnish coast. Due to the general increase of salinity and nutrients in the Gulf of Finland, the chlorophyll a concentration and biomass increased, and the species composition became more marine in character in the late seventies. After the first unit of the power station came into use in 1977, the increase of the average phytoplankton quantities was greater in the area in which the cooling water was discharged than in the intake area. The changes in the species composition were similar in the two areas. The warmed water did not cause significant alterations in the winter plankton, but seemed slightly to advance the start of the spring phytoplankton phase in the discharge area. The temperature rise had a stimulative effect on the phytoplankton during the growing period. Nutrients, however, were a more important regulating factor than temperature for both the chlorophylla concentration and phytoplankton biomass. (Author's abstract)
W88-09940

VEGETATION AND ECOLOGY OF MESOTROPHIC AND EUTROPHIC FENS IN WESTERN FINLAND,
Helsinki Univ. (Finland). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W88-09941

PHYTOPLANKTON IN THE SEA AREA OFF THE OLKILUOTO NUCLEAR POWER STATION, WEST COAST OF FINLAND,
Finnish Centre for Radiation and Nuclear Safety, Helsinki.
J. Keskitalo.
Annales Botanici Fennici ABOFAQ, Vol. 24, No. 3, p 281-299, 1987. 9 fig, 5 tab, 40 ref, append.

Descriptors: *Nuclear powerplants, *Cooling water, *Coastal waters, *Phytoplankton, *Temperature effects, *Population dynamics, *Population exposure, *Water pollution effects, Finland, Salinity, Diatoms, Chlorophylla, Species composition, Seasonal variation, Ecological effects, Limiting nutrients, Biomass, Spatial distribution, Okiluoto Nuclear Plant, Bothnian Sea.

In 1972-1982 phytoplankton was studied by the methods of Lorenzen and Utermohl in the sea area that since 1978 has received cooling water from the Olkiluoto nuclear power station. Throughout the study period, the species composition was typical of oligotrophic coastal waters of the Bothnian Sea. The diatom Chaetoceros wighamii usually predominated in spring and flagellates prevailed in summer. The chlorophyll a concentration and phytoplankton biomass (fresh weight) increased in the late seventies and early eighties, due to the general increase of nutrients in the Baltic Sea. The thermal discharges advanced the spring biomass peak in the discharge area by < or = 2 weeks, but did not otherwise change the seasonal rhythm. The discharges seemed to slightly increase the abundance of the diatom Rhizosolenia minima, and also that of diatoms derived from the benthos. However, the temperature rise did not markedly affect the total phytoplankton quantities in the discharge area. Nutrients and salinity were the most significant factors explaining changes in the chlorophyll a concentration and total biomass. (See W88-09938 thru W88-09939) (Author's abstract)
W88-09942

TOXICITY OF INDUSTRIAL EFFLUENTS TO THE FRESHWATER CAT FISH MYSTUS KELETIUS,
Saint Xavier's Coll., Palyamkottai (India). Dept. of Zoology.
S. S. M. A. Raj, A. G. Murugesan, and M. A. Haniffa.
Current Science, Vol. 56, No. 14, p 733-735, July 1987. 1 fig, 1 tab, 12 ref.

Descriptors: *Catfish, *Water pollution effects, *Bioassay, *Limnology, *Toxicity, Fish physiology, Industrial wastewater, Biological oxygen demand, Chemical oxygen demand, Effluents, Fish, Distillery wastes, Textile mill wastes, Fish behavior, Mortality, Survival.

Mortality of the cat fish, Mystus keletius was studied as a function of resistance time at different concentrations of distillery and textile mill effluents. No mortality was observed in the control fish. The behavioral response of the test fish varied in accordance with the concentration and type of effluent. Increase in concentration of effluent caused behavioral changes such as erratic movements, increased opercular movements and rapid jerky movements. M. keletius died more rapidly at concentrations above 5% distillery effluent and 10% textile mill effluent. The lowering concentration in 120 hr LC50 values when compared with the 1 hr ones in both distillery and textile mill effluents suggests the decrease in resistance of M. keletius with increase in experimental time. The higher LC50 values at different intervals in textile mill effluent denote the greater resistance of M. keletius. The results clearly indicate that distillery effluent is comparatively more toxic than textile mill effluent. LC50 in distillery effluent at different intervals ranged between 2.5 and 7% and the same in textile mill effluent ranged from 6 to 13%. Distillery effluent was 1.9 to 2.7 times more toxic than textile mill effluent when LC50 and LC84 were considered and 2 to 2.8 times greater for LC16. When compared with the textile mill effluents, the toxic effect in distillery effluent was greater due to its very high BOD, COD and the total dissolved solids but the comparative effect is more or less the same irrespective of percentage mortality. (Alexander-PTT)
W88-09946

RED TIDE IN SOUTHERN NORWAY CAUSED BY MASS OCCURRENCE OF THE PLANKTONIC CILIATE TIARINA FUSUS (RODT VANN VED TVEDESTRAND-MASSEFOREKOMST AV FLIMMERDYRET TIARINA FU),
For primary bibliographic entry see Field 2L.
W88-09948

WATER QUALITY CHARACTERISTICS OF A SOUTHEAST FLORIDA SEWAGE TREATMENT AND BIOEFFECTS LABORATORY,
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
For primary bibliographic entry see Field 5D.
W88-09950

DISTRIBUTION OF FLORA AND FAUNA IN AN AREA RECEIVING PULP MILL EFFLUENTS IN THE BALTIC SEA,

Stockholm Univ. (Sweden). Dept. of Zoology.
H. Kautsky, U. Kautsky, and S. Nellbring.
Ophelia OPHLAN, Vol. 28, No. 2, p 139-155, April 1988. 6 fig, 41 ref.

Descriptors: *Pulp wastes, *Benthic flora, *Water pollution effects, *Benthic fauna, *Algae, *Baltic Sea, Spatial distribution, Species composition, Population dynamics, Coastal waters, Industrial wastewater, Toxicity, Biomass, Aquatic plants, Aquatic habitats, Aquatic animals, Food habits, Food chains, Trophic level, Fish, Estuarine environment.

The quantitative distribution of macroscopic plant and animal species in the area receiving effluents from the sulfate pulp mill in Norrsundet, Bothnian Sea, is described. SCUBA-techniques were used to sample the bottoms. Close to the outlet turbidity and the load of cellulose fibres restrict species distribution, while in the intermediate area toxic substances seem to inhibit the growth of many species found further out. Species composition changes, and the number of species and the biomass increase with the distance from the outlet and are highest at the reference station. Green algae, mainly Cladophora aegagrophila, have a very high biomass close to the pulp mill but this decreases further out and contributes only a few percent to total biomass at the outer stations. In the intermediate area phanerogams, mosses and red algae increase, while brown algae occur only in the outer area. Fucus vesiculosus and Characeae dominate at the unpolluted reference station. Animal biomass is dominated by Macoma balthica and Lymnaea spp. in the whole area. Hydrobia spp. and Gammarus app. contribute much to total animal biomass in the outer area whereas insect larvae are important in the intermediate parts. There is a tendency for fish density to increase in the intermediate area. This may be due to the occurrence of some major food organisms in the littoral zone, with an even distribution of 4 species. Functional groups of animals, as reflected by trophic levels, are also evenly distributed in the intermediate area. (Author's abstract)
W88-09952

DENSITIES OF PROTOZOAN NANOPLANKTON POPULATIONS IN INTERTIDAL MESOCOSMS: INFLUENCE OF OIL POLLUTION AND A SELF-IGNITING CLEANING AGENT,
Nederlands Inst. voor Onderzoek der Zee, Texel.
R. P. M. Bak, and G. Nieuwland.
Netherlands Journal of Sea Research NJSRBA, Vol. 21, No. 4, p 303-315, December 1987. 10 fig, 66 ref.

Descriptors: *Protozoa, *Intertidal areas, *Oil spills, *Cleanup operations, *Oil pollution, *Water pollution effects, Ecological effects, Species composition, Population dynamics, Biomass, Coastal waters, Aquatic habitats, Trophic level, Zooplankton, Food habits, Food chains, Netherlands.

Population densities of small pelagic protists were studied in intertidal mesocosms. The mesocosms represented tidal flats of the adjacent Wadden Sea under 3 sets of environmental conditions: control, oil spill, and oil spill treated with a new type of cleaning agent (granular, self-igniting). There were obvious effects, such as the almost complete elimination of ciliates and the reduced filtering by macrozoobenthos, upon the introduction of the pollutants in the experimental conditions. Within 3 days, heterotrophic flagellate densities increased exponentially to return to pre-oil-spill levels in two weeks. Maximum densities of heterotrophic flagellates corresponded with a period of low bacterial numbers, suggesting that trophic coupling exists during the inactivity of filter feeders. Such a pattern did not exist for the autotrophic nanoplankton. The effects of the oil plus cleaning agent treatment were more pronounced than the effect of oil. The absence of fluctuations in population densities in the control mesocosm and the emergence of such fluctuation patterns under experimental conditions, with reduced activity of benthic filter feeders, indicate that predation by the benthic fauna is a structuring factor for the heterotrophic nanoplankton in such intertidal systems. (Author's abstract)
W88-09953

LEGIONELLA PNEUMOPHILA,
John Radcliffe Hospital, Headington (England). Dept. of Virology.
For primary bibliographic entry see Field 5B.
W88-09961

ENHANCED REPRODUCTIVE POTENTIAL OF NEOCHETINA BRUCHI HOSTACHE FED ON WATER HYACINTH PLANTS FROM POLLUTED WATER BODIES,
Regional Research Lab., Hyderabad (India).
K. Jaimil, and K. N. Jyothi.
Current Science CUSCAM, Vol. 57, No. 4, p 195-197, February 20, 1988. 3 fig, 2 tab, 12 ref.

Descriptors: *Water pollution effects, **Biocontrol, *Water hyacinth, Aquatic weed control, *Insects, *Industrial wastes, Water hyacinth, Fecundity, Nutrition, Tissue analysis.

Eichornia crassipes, commonly known as the water hyacinth, has become a cause of much concern in recent years due to its role as weed pest. Several pathogens, mites, insects and other arthropods attack this weed, of which two species, Neochetina eichorniae and N. bruchi, have been found as promising biocontrol agents. These 2 species have been introduced in India and a number of host specificity studies have been carried out. Since female insects have special nutritional requirements for reproductive purposes, the effects of various chemicals on plants may affect the insect species feeding on them. Therefore, the reproductive activity of Neochetina bruchi fed on water hyacinth plants grown in polluted water, rich in several inorganic molecules, was studied. Water hyacinth plants were collected from two different polluted areas around Hyderabad. The water bodies are heavily contaminated with industrial effluents from nearby industries. The mineral analysis of water hyacinth leaves from polluted water bodies predominantly showed the presence of magnesium, aluminum and calcium. The increase in protein and sterol content of the leaves from polluted water bodies coupled with various inorganic minerals appeared to have resulted in an increased fecundity of the weevils. (Brock-PTT)
W88-09970

IMPACT OF UREA TOP DRESSING OF FOREST WATER CATCHMENT AREAS ON THE BIOLOGICAL SUFFICIENCY AND WATER QUALITY IN MOUNTAIN STREAMS: III. MACROZOOBENTHIC PRODUCTION,
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
Y. I. Uzunov, and S. G. Kovachev.
Hydrobiology, Vol. 30, p 62-80, 1987. 16 fig, 2 tab, 11 ref.

Descriptors: *Mountain streams, *Forests, Catchment areas, *Benthic fauna, *Urea top dressing, *Water pollution effects, *Eutrophication, *Path of pollutants, Water quality, Aquatic environments, Streams, Ecology, Fauna, Biomass, Fertilizers, Streams, Productivity, Bulgaria, Aquatic insects, Amphipods, Turbellaria.

The effects of experimental urea top dressing of forest water catchment areas on macrozoobenthic productivity in Bulgarian mountain streams was examined. The annual production of the benthic communities within the studied stream system was assessed on the average at 58.6 g/sq m. It was lower in the tributaries (53.4 g/sq m) than in the main stream (60.9 g/sq m) where the maximum production (P) value was registered (77.6 g/sq m). The amphipod G. balcanicus (an average 40.1%), the representatives of Ephemeroptera (14.8%), Diptera (11.1%), Turbellaria (10.7%), and Trichoptera (9.8%), play a major role in the formation of the annual production. Despite the fact that the proportion of single groups in the total production from the experimental streams is lower than in the control streams, the treatment of water catchment areas did not influence directly the productivity of benthic populations. The differences observed in the P values in the different points correspond to the level of the respective biomasses. There were no indications that production processes were disrupted. The established higher level of P in the experimental streams with respect to their control streams, however, has been interpreted as a result of the unfavorable effects of urea top dressing connected with the restructuring of the macrozoobenthos and the lowering of species diversity and evenness in the community, as well as with the increasingly structure-determining role of one species or a group of species in the production process. These secondary effects have been explicitly expressed in the experimental stream treated twice with urea in 1982 and 1983, while in the stream treated only in 1981, they are not so significant. Irrespective of the fact that the zoobenthic production in the experimental stream increased, this phenomenon should be interpreted as an unfavorable effect from urea treatment of water catchment areas, for it is a direct consequence of the disrupted structure organization of benthic communities. The observation of such an 'overproductivity' 2 or 3 yr after treatment demonstrates the stricter and more extensive control by urea top dressing effects on stream zoocenoses. (Roseman-PTT)
W88-09971

EFFECTS OF SEWAGE DUMPING ON MACROBENTHIC INVERTEBRATES IN THE JORDAN GULF OF AQABA, RED SEA,
Jordanian Marine Science Station, Aqaba.
N. S. Ismail, and J. Awad.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 2, p 225-234, 1987. 4 fig, 6 tab, 21 ref.

Descriptors: *Wastewater, *Water pollution effects, *Wastewater disposal, *Benthic fauna, *Macroinvertebrates, *Gulf of Aqaba, Red Sea, Water pollution, Invertebrates, Aquatic Animals, Jordan.

There are two sewage outfalls along the Jordanian coastline of the Gulf of Aqaba. During 1982 and 1983 a total of 328 core samples (0.01 sq m to a depth of 15 cm) were collected from the two outfalls, two control stations which resemble the outfalls in depth and sediment texture, and from two stations 100m on both sides of each outfall. Faunal analysis revealed that the total number of individuals, number of species, species richness, and faunal similarities of macrobenthic invertebrates were lower at the sewage outfall near the phosphate loading port than the control station during both collections. At the 100m stations, the numbers of individuals were generally higher than the sewage and control stations. The number of species, however, was highest at the control station and lowest at the sewage outfall. At the other sewage outfall, where the sewage effluent was discharged sporadically, no measurable effects on macrobenthic invertebrates were found. (Author's abstract)
W88-09996

5D. Waste Treatment Processes

1987 ANNUAL BOOK OF ASTM STANDARDS.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 7B.
W88-08986

1987 ANNUAL BOOK OF ASTM STANDARDS.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5A.
W88-08987

COMMENTS ON EPA'S EFFLUENT LIMITATION GUIDELINES FOR THE NONFERROUS METALS MANUFACTURING INDUSTRIES.
JACA Corp., Fort Washington, PA.
For primary bibliographic entry see Field 5E.
W88-09029

HANDBOOK OF HAZARDOUS WASTE MANAGEMENT FOR SMALL QUANTITY GENERATORS,
For primary bibliographic entry see Field 5E.
W88-09030

STABILIZATION AND ISOLATION OF LOW-LEVEL WASTE DISPOSAL SITES,
Rockwell International, Richland, WA. Rockwell Hanford Operations.
For primary bibliographic entry see Field 5E.
W88-09037

ANAEROBIC FLUID-BED TREATMENT OF COAL CONVERSION WASTEWATER,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
M. T. Suidan, J. T. Pfeffer, G. F. Nakhala, and U. K. Traegner.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-011218. Price codes: A02 in paper copy, A01 in microfiche. 1987. 7 p, 1 fig. Contract No. DE-FG22-86PC90514. Report No. DOE-PC-90514-T3.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Fluidized bed process, *Anaerobic digestion, *Activated carbon, *Model studies, Detention time, Performance evaluation, Adsorption, Biological wastewater treatment, Mathematical models, Coal gasification, Biodegradation, Organic compounds, Phenols, Cresols, Acetic acid, Coal.

The effects of hydraulic detention time and the schedule of granular activated carbon (GAC) replacement on the treatment of a coal conversion wastewater in an anaerobic fluidized-bed granular activated carbon (GAC) reactor were examined by experimental and modeling strategies. Two expanded-bed GAC anaerobic reactors were operated at empty-bed hydraulic detention times of 1.0 and 0.5 days (reactors 1 and 2, respectively). The wastewater fed to the reactors included phenol, acetic acid and o-cresol as model compounds of a real coal conversion wastewater. A mathematical model of the expanded-bed GAC anaerobic reactor was developed that incorporated the various interactions that occurred in the process such as biodegradation, adsorption only GAC, and the regular replacement of reactor GAC with virgin media. The calibrated model was used to analyze a vast volume of experimental data on the treatment of coal gasification wastewater and refinery sour stripper bottoms using fluidized bed GAC anaerobic reactors. The rate of increase in the effluent o-cresol concentration from reactor 1 was much slower than that of reactor 2 which indicates the effect of hydraulic detention time on non-steady state performance. The replacement of the reactor GAC with virgin carbon was found to remove a considerable amount of phenol and decrease the percent conversion of the degradable COD. The homogeneous solid diffusion model was fitted to the experimental batch test results. It was found that the initial adsorption rate is rapid but slows significantly afterwards. Attempts are being made to consider the pores in the carbon to be twofold in nature, and therefore, two different sets of surface diffusion coefficients are being investigated. The effect of the effluent o-cresol concentration on reactor performance will be assessed by comparing the two reactors with a third reactor currently treating phenol and acetate only with the same GAC replacement rate as reactors 1 and 2. (Geiger-PTT)
W88-09038

PHOSPHATE REMOVAL FROM EFFLUENTS,
National Inst. for Water Research, Pretoria (South Africa).
W. V. Alexander.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-225637. Price codes: E04 in paper copy, A01 in microfiche. 1985. 20 p, 5 fig, 14 ref.

Descriptors: *Phosphorus removal, *Wastewater treatment, *Biological wastewater treatment, *Waste disposal, Phosphorus, Chemical treatment, Phosphates, Anaerobic digestion, Sludge disposal, Land disposal, Fatty acids, Sludge fermentation, Bacteria, South Africa, Reeds, Effluents, Biofiltration.

An overview of the existing state of the art of phosphorus removal from effluents is given with emphasis on new developments in the field and how they effect the design of phosphorus removal installations. Biological, chemical, and reedbed processes are reviewed. Acinetobacter is the predominant species with the ability to accumulate poly-phosphate (poly-P). Poly-P organisms grow preferentially on lower fatty acids as substrate. Primary settling tanks have been used to promote lower fatty acid production through fermentation. The City Council of Johannesburg, South Africa, has done a great deal of work in the optimization of their biological nutrient removal plants. A major disadvantage in implementing primary sludge fermentation is that the addition of high concentrations of lower fatty acids to the anaerobic zone appears to give rise to the growth of filamentous organisms in the plant with resultant sludge bulking. Some options for handling phosphorus-rich sludge are: fixing with lime before discharge to the dewatering beds; thickening by dissolved air flotation or gravity thickening; and stripping of phosphorus prior to entering the digester for further anaerobic digestion or treating chemically the digester supernatant. Chemical removal of dissolved phosphorus from supernatants may be accomplished by metal salt dosing, lime dosing, biofiltration, activated sludge, and calcium phosphate crystallization. The removal of phosphorus by reedbeds is described. Working reedbeds for removing phosphorus at the Mpophomeni Sewage Works in Kwa Zulu, the Grootvlei Power Station, and the NIWR Experimental Facilities at Daspoort are described along with a reedbed for dewatering phosphorus rich waste activated sludge. (Geiger-PTT)
W88-09048

WASTEWATER STABILIZATION PONDS: PRINCIPLES OF PLANNING AND PRACTICE.
World Health Organization, Alexandria (Egypt). Regional Office for the Eastern Mediterranean. World Health Organization, Alexandria, Egypt. WHO EMRO Technical Publication No. 10. 1987. 18 fig, 6 tab, 48 ref, Append, Annex.

Descriptors: *Wastewater treatment, *Wastewater facilities, *Biological treatment, *Stabilization ponds, *Design criteria, Management planning, *Arid lands, *Technology transfer, Mediterranean region, Water reuse, Wind, Temperature, Bacteria, Algae, Light, Optimization, Costs, Operations, Maintenance, Ponds, Construction methods, Anaerobic digestion, Developing countries, Land costs.

This book on wastewater stabilization ponds is intended to provide information useful for both large and small communities in the eastern Mediterranean region. The effluent from a well-designed pond can be discharged into local water bodies without polluting them and it also can serve as a valuable resource in irrigation or fish culture. If inexpensive land is available, wastewater stabilization ponds are the cheapest and most effective means of treating communal wastewaters. Shortage of land is not usually a problem in the countries of the eastern Mediterranean. The pond systems make use of sunlight, wind, temperature, and bacterial and algal growth to produce a reusable effluent. The task of the pond designer is to optimize the interaction of these factors. The operation and maintenance of the ponds requires minimal operator skills and running costs, making them particularly suited for developing countries. This book is divided into two parts: the first part is intended for national and local administrators and decision makers who must choose between competing systems of wastewater treatment, whereas the second part is intended for persons involved in making the preliminary designs on which cost estimates are based. A worked example and simple methodology to help the designer are included. Among the specific topics covered are the following: factors affecting the performance of treatment ponds; pond failure; factors related to facultative ponds in warm regions; wastewater treatment in hot and arid regions; upgrading pond effluent; pond construction, lining, and appurtenances; pond installation and equipment; operations, maintenance, and safety; management; and design of anaerobic ponds, facultative ponds, and maturation ponds. (Rochester-PTT)
W88-09084

REMEDIAL PROGRAMS FOR GROUNDWATER SUPPLIES CONTAMINATED BY GASOLINE,
For primary bibliographic entry see Field 5G.
W88-09134

TREATMENT TECHNOLOGY FOR REMOVAL OF DISSOLVED GASOLINE COMPONENTS FROM GROUND WATER,
R. D. Allan, and C. S. Parmele.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 51-59, 14 fig, 1 tab, 6 ref.

Descriptors: *Groundwater pollution, *Water pollution treatment, *Water treatment, *Activated carbon, *Gasoline, *Adsorption, *Cleanup operations, Evaluation, Air stripping, Regeneration, Steam regeneration, Activated carbon, Aromatic compounds.

This paper describes an evaluation, conducted by the American Petroleum Institute (API) and IT Enviroscience (ITE), of activated carbon adsorption and air stripping (or a combination of these technologies) for treating groundwater containing dissolved gasoline components. The adsorption capacities of two activated carbons, Witcarb 950 and Filtasorb 400, were compared. Witcarb 950 was chosen for subsequent experiments because of its superior handling and operational qualities. Use of a pretreated feed preparation was found superior to synthetic feeds because it was judged to be more representative of real world conditions. Effluent sample quality on regenerated carbon was found to be much better at 6 ft than at 3 ft. For regeneration, a total of seven cycles were run on a single sample of Witco carbon at a hydraulic loading of 7 gpm/sq ft. The carbon was then regenerated with steam for three successive runs. These runs achieved a stable working capacity at 0.11 g total organics of interest (TOI)/g carbon, approximately 75% of the virgin loading. These results suggested that regeneration within steam at the proper conditions can result in a viable process, providing stable working capacity of the carbon and good effluent quality. The air stripping apparatus consisted of a 1-1/2 in diameter glass column filled with 1/4-in nominal diameter berl saddles to a depth of 22 in. Based on the experimental results of this project, both carbon adsorption and air stripping are effective in removing aromatic gasoline components from ground water. Air stripping is also effective in removing methyl t-butyl ether (MTBE), but neither technology is capable of removing t-butyl alcohol (TBA). (See also W88-09129) (Friedmann-PTT)
W88-09136

TREATMENT ALTERNATIVES EVALUATION FOR AQUIFER RESTORATION,
For primary bibliographic entry see Field 5G.
W88-09141

DESIGN, OPERATION AND RESULTS OF A PILOT PLANT FOR REMOVAL OF CONTAMINANTS FROM GROUND WATER,
Weston (Roy. F.) Inc., Concord, NH.
For primary bibliographic entry see Field 5G.
W88-09143

OIL SPILL CHEMICAL DISPERSANTS: RESEARCH, EXPERIENCE, AND RECOMMENDATIONS.
American Society for Testing Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5G.
W88-09183

GROUNDWATER TREATMENT TECHNOLOGY,
DETOX, Inc., Dayton, OH.
For primary bibliographic entry see Field 5G.
W88-09238

FIXED-FILM BIOREACTOR TO TREAT TRICHLOROETHYLENE-LADEN WATERS FROM INTERDICTION WELLS,
Oklahoma Univ., Norman. Environmental and Ground Water Inst.
B. H. Wilson, and M. V. White.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 425-436. 1 fig, 3 tab, 13 ref. EPA Agreement CR-811146 and USAF Interagency Agreement RW57930615-01-1.

Descriptors: *Water pollution treatment, *Wastewater treatment, *Biological wastewater treatment, *Trichloroethane, *Chlorinated hydrocarbons, *Hydrocarbons, *Groundwater pollution, *Biodegradation, Microorganisms, Fate of pollutants, Aquifers, Design criteria, Water quality, Design standards, Economic aspects, Microbiological studies, Groundwater, Trichloroethylane, Trichloroethane, Air stripping, Propane, Performance evaluation.

Water from interdiction wells must have trichloroethylene and 1,1,1-trichloroethane removed before disposal into sanitary sewer systems or reinjection occurs. This paper discusses a laboratory scale prototype of a biological treatment system more cost efficiently than those currently used. The design is concurrent flow through coarse sand of water containing trichloroethylene and 1,1,1-trichloroethane and air enriched with propane or natural gas. Concurrent flow is used to prevent stripping of trichloroethylene or 1,1,1-trichloroethane and generating a contaminated air stream. The sand was exposed to propane to enrich for organisms that oxidized gaseous alkanes. These organisms have an enzyme that will oxidize and dechlorinate halogenated compounds along with the alkanes. Previous work by this author using an unsaturated column showed extensive trichloroethylene removal with carbon dioxide confirmed as the product of degradation. Other workers have demonstrated a similar removal of 1,1,1-trichloroethane supported on propane. In the bioreactor the metabolism of 20 mg of propane per liter of water treated reduced the concentration of trichloroethylene an order of magnitude. For reasons that are unclear 1,1,1-trichloroethane was not removed in our bioreactor. (See also W88-09283) (Author's abstract)
W88-09317

FIELD DEMONSTRATION OF ENHANCED BIORECLAMATION,
FMC Corp., Princeton, NJ. Aquifer Remediation Systems.
For primary bibliographic entry see Field 5G.
W88-09318

TEMPERATURE EFFECTS ON PACKED AERATION TOWER PERFORMANCE,
Geraghty and Miller, Inc., Oak Ridge, TN.
P. D. Kuhlmeier.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 592-607. 5 fig, 2 tab, 4 ref.

Descriptors: *Air stripping, *Wastewater treatment, Temperature effects, *Design criteria, Design standards, Seasonal variation, Physical properties, Hydrocarbons, Hydrodynamics, Organic compounds, Chlorinated hydrocarbons, Performance evaluation, Groundwater, Pilot plants.

Air stripping tower efficiency and tower hydraulic characteristics are strongly dependent on the water and air design temperatures. As the water temperature drops, both Henry's constants and mass transfer coefficients decrease, making removal by stripping more difficult. In areas of the country where wide variances of temperature are common, system design for year around operation becomes more difficult. For example, if air and water temperatures of 20 deg C each decrease in the winter months to -12 C and 5 C respectively, the height of the required tower could increase three fold. Henry's constant for most volatile hydrocarbons has also been shown to increase threefold for every 10 C temperature rise. A series of pilot tests were conducted on a wastestream of constant water quality at varying flowrates, air temperatures and water stripper performances. Influent water was spiked with 1,1,1 trichloroethane, trichloroethylene and tetrachloroethylene as the compounds to be removed. Results presented here are currently being tested in the design of packed towers for operation in northern climates. (See also W88-09283) (Author's abstract)
W88-09327

LARGE-SCALE HIGH-EFFICIENCY AIR STRIPPER AND RECOVERY WELL NETWORK FOR REMOVING VOLATILE ORGANIC CHLOROCARBONS FROM GROUND WATER,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
For primary bibliographic entry see Field 5G.
W88-09328

CASE HISTORY - TREATMENT OF CONTAMINANT GROUND WATER USING ELEVATED TEMPERATURE AIR STRIPPING,
Rexnord, Inc., Milwaukee, WI. Corporate Research and Development Group.
For primary bibliographic entry see Field 5G.
W88-09329

ALTERNATIVE SEWER SYSTEMS.
Water Pollution Control Federation, Alexandria, VA.
Water Pollution Control Federation, Alexandria, Virginia. Manual of Practice No. FD-12, 1986. 105 p.

Descriptors: *Sewer systems, *Wastewater collection, *Sewers, Costs, Economic aspects, Maintenance, Gravity sewers, Vacuum sewers, Pipes.

The purpose of this document is to provide guidance to engineers and regulatory and local officials who are contemplating the use of or who are responsible for the management of alternative wastewater collection systems. These systems have been developed over the past two decades to provide cost-effective wastewater collection in areas of lower population density where conventional sewers may be prohibitively expensive and on-site wastewater treatment and disposal systems technically infeasible. For example, in very small communities in which downhill slopes lead to treatment sites and there is minimal operation and maintenance capability, a small-diameter gravity (SDG) sewer system should be considered. Similarly, in small communities where the optimum treatment and disposal facilities are to be located at an elevation higher than the community, a septic tank effluent pump (STEP system is a logical candidate. In small fringe areas which are at low elevation in relation to a larger conventional sewer, a grinder-pump (GP) system could possibly be the optimum choice. In relatively flat areas with reasonably dense suburban development, vacuum sewers should be considered as a potential solution. Combinations of alternative sewers are also feasible as a cost-effective solution. SDG and STEP systems have been combined with excellent results. Combinations of GP, conventional gravity, and vacuum systems are also used. The design engineer must consider not only each alternative sewer, but combinations which use the inherent advantages of compatible systems. (Lantz-PTT)
W88-09357

CHEMICAL AND TOXICOLOGICAL ASPECTS OF SUPERFUND SITE CLEANUP,
ENVIRON Corp., Princeton, NJ.
For primary bibliographic entry see Field 5G.
W88-09376

SURVEYS OF REMEDIAL ACTIONS AT SUPERFUND SITES,
Soil and Material Engineers, Inc., Bordentown, NJ.
For primary bibliographic entry see Field 5G.
W88-09378

U.S. EPA RESEARCH ON IN-SITU TREATMENT TECHNOLOGY,
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
D. E. Sanning, and R. F. Lewis.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 75-98, 1 tab, 34 ref.

Descriptors: *Water pollution control, *Water pollution treatment, *Wastewater treatment, *Waste disposal, *Cleanup operations, *In-situ treatment, Path of pollutants, Soil contamination, Biodegradation, Chemical treatment, Extraction, Immobilization, Groundwater management, Waste recovery, Case studies, Remedies.

In-situ treatment can be effective in eliminating or reducing the hazardous wastes to acceptable levels. In-situ treatment of contaminated soils must be based on an understanding of factors and processes that determine the behavior of chemicals in soil systems. Specifically, an evaluation of chemical properties, biochemical processes, and environmental factors influencing the behavior and fate of chemicals is required. The goals of in-situ management include treating contaminated soils until acceptable levels of hazardous materials are achieved so that groundwater and surface water resources are protected. In those cases where in-situ treatment is determined to be a feasible approach, it will usually be implemented as a part of an overall remedial action scenario involving the use of other methodologies (e.g. containment) in parallel. This paper gives a general overview/problem definition and state-of-the-art of the natural processes of biodegradation and chemical transformations. The importance and problems of delivery and recovery systems are emphasized. In-situ treatment technologies are classified into extraction processes (air-stripping, flushing, freezing, electrokinetics, vegetative and thermal) and immobilization processes (grouting, fixation, thermal fusion, chemical and biological). Documented case histories of in-situ treatment at several sites are presented, including some of the ongoing and completed EPA/ORD activities. (Lantz-PTT)
W88-09380

REMEDIAL TECHNOLOGIES FOR LEAKING UNDERGROUND STORAGE TANKS.
Weston (Roy F.), Inc., Concord, CA.
For primary bibliographic entry see Field 5G.
W88-09402

INSTRUMENTATION: HANDBOOK FOR WATER AND WASTEWATER TREATMENT PLANTS,
EMA, Inc., St. Paul, MN.
R. G. Skrentner.
Lewis Publishers, Chelsea, Michigan. 1988. 295 p.

Descriptors: *Measuring instruments, *Instrumentation, *Wastewater treatment, *Water treatment, Water quality control, Wastewater facilities, Water treatment facilities, Flow, Pressure-measuring instruments, Maintenance, Pumps.

Instrumentation required for proper operation of water and wastewater treatment plants was studied and found to be in various states of working order at treatment plants. Personnel at these sites often criticized the instrumentation for failure to meet reliability and usefulness expectations. However, the same instrumentation performed satisfactorily in other locations. Information is provided for engineers and operators about the prerequisites for success with instrumentation. The material in this book is intended as a guide for the selection, application, and maintenance of primary elements and final control elements. The first six chapters cover basic, proven primary elements that meet specific needs and provide tangible benefits. For each instrument, the following information is provided: (1) application; (2) principle of operation; (3) accu-

racy and repeatability; (4) manufacturers' options; (5) installation; (6) designer checklist; (7) maintenance and calibration; (8) deficiencies; and (9) references. The instruments perform the following tasks: (1) analytical measurement; (2) flow measurement; (3) level measurement; (4) pressure measurement; (5) quality assurance testing; (6) pumps for variable flow service; (7) variable speed drives; (8) control valves for modulating service; (9) control valve actuators; and (10) process control instrumentation. (Lantz-PTT)
W88-09403

SEPTIC SYSTEMS HANDBOOK,
O. B. Kaplan.
Lewis Publishers, Chelsea, Michigan. 1987. 290 p.

Descriptors: *Soil disposal fields, *Percolation tests, *Wastewater treatment, *Septic tanks, *Leachfields, *Handbooks, Leaching, Public health, Regulations, Groundwater quality, Economic aspects, Parasites.

Ponded sewage near inhabited areas may afflict residents in various ways. As a nuisance, it may generate offensive odors, it may attract rodent pests, and it may serve as a breeding ground for mosquitoes and flies. As a health hazard, sewage may contain parasitic worms' eggs and larvae, and also microbial pathogens and parasites. Of the 'top five' human parasitic diseases, each with about half a million to a million cases per year worldwide (ascariasis, hookworm, malaria, trichuriasis, and amoebiasis), only one (malaria) is not directly spread in sewage. Sewers carry sewage away from its point of origin to a faraway treatment plant or disposal area. Onsite systems treat and/or discharge sewage within the site where the sewage originates. The most common type of onsite system is the septic system, also called the septic tank sewage disposal system, or septic tank soil absorption system (ST-SAS). Approximately one-third of all houses in the United States are served by septic systems: either the septic tank itself, or a type of leachfield or soil absorption system. This handbook discusses septic systems from the standpoint of: economics, soil water, leachlines, groundwater quality, mounding, permits, regulations, and public health. (Lantz-PTT)
W88-09404

ALTERNATIVE ENDPOINTS FOR RECLAMATION,
Liverpool Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 6A.
W88-09459

POLITICAL AND SOCIAL FACTORS IN THE PATUXENT RIVER CLEANUP AGREEMENT,
ERM, Inc., Exton, PA.
For primary bibliographic entry see Field 5G.
W88-09461

HUMAN VIRUSES IN SEDIMENTS, SLUDGES, AND SOILS.
For primary bibliographic entry see Field 5B.
W88-09463

PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEDIMENT, SLUDGES, AND SOILS,
Houston Univ., TX. Dept. of Civil Engineering.
J. V. Matson, C. L. Lowry, Y. M. Chan, and M. E. Whitworth.
IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 3-20, 7 fig, 7 tab, 27 ref.

Descriptors: *Sediments, *Sludges, *Soils, *Water pollution sources, *Soil properties, Cation exchange, Weathering, Viruses, Microorganisms, Oxidation-reduction reactions, Chemical properties, Physical properties, Organic matter, Organic compounds, Inorganic compounds, Hydrogen ion concentration, Chemical reactions.

It is important to understand the principles governing the interactions of sediments, sludges, and soils with human viruses, for the development of methods in virus recovery and in studies relating to virus persistence and inactivation. The physical and chemical characteristics of both sediments and sludge are explained here, as well as the characteristics of soil, specifically: (1) soil texture and structure; (2) organic materials in soils and its effect on physical properties; (3) organic and inorganic colloids; and (4) chemical characteristics of soil (cation exchange capacity, pH, weathering reactions, redox reactions, adsorption). The relationship of these materials to the water environment has been studied for years by geologists, soil scientists, and environmental engineers. These professionals have developed a vocabulary for describing the physical and chemical properties of the materials. The vocabulary terms are explained here and some examples are used to illustrate the principles involved. Finally, the relevance of the materials to the environment is explored. (See also W88-09463) (Lantz-PTT)
W88-09464

METHODS FOR CONCENTRATION AND RECOVERY OF VIRUSES FROM WASTEWATER SLUDGES,
Florida Univ., Gainesville. Dept. of Microbiology and Cell Science.
For primary bibliographic entry see Field 5A.
W88-09469

MECHANISM OF VIRUS INACTIVATION IN WASTEWATER SLUDGES,
James N. Gamble Inst. of Medical Research, Cincinnati, OH.
R. L. Ward.
IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 101-110, 85 ref. EPA Contract Nos. R-810821 IN:-01-0 and R-811183-01-1.

Descriptors: *Wastewater treatment, *Disinfection, *Viruses, *Sludge, Anaerobic digestion, Aerobic digestion, Composting, Hydrogen ion concnetration, Temperature, Public health, Lime, Irradiation, Pasteurization, Heat treatment, Air drying.

Viruses in wastewater sludge are inactivated during both conventional (anaerobic digestion, aerobic digestion, composting, lime treatment, and air drying) and nonconventional (irradiation, pasteurization, thermophilic aerobic digestion, and heat drying) treatment processes. The mechanisms of inactivation during these processes depend on factors such as pH, temperature, chemical and biological composition, and moisture content. Because viruses do not replicate in sludge, their inactivation results in reducing the potential health risks associated with sludge use or disposal. (See also W88-09463) (Lantz-PTT)
W88-09470

FATE OF VIRUSES DURING SLUDGE PROCESSING,
Wisconsin Univ.-Madison. Food Research Inst.
D. O. Cliver.
IN: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 111-127, 1 fig, 1 tab, 66 ref.

Descriptors: *Viruses, *Sludge digestion, *Wastewater treatment, Hydrogen ion concentration, Temperature, Pasteurization, Heat treatment, Detergents, Sludge, Public health, Costs.

Sludge processes have generally been designed to take the so-called solids from wastewater treatment and stabilize them so that they do not create a nuisance (odor or other) when disposed of where they impact on the public. Enteroviruses have regularly been used as indicators of the probable presence of potentially water- or food-borne viruses in sludge and to determine the extent of viral inactivation in sludge treatment. Only a few other model viruses, including coliphages, have been employed in this way. The extent of viral inactivation seems to depend largely on the length of time the sludge is held at certain temperatures and on pH. The enteroviruses become increasingly labile with increasing temperature in the mesophilic range and are rapidly inactivated in the thermophilic range, especially at temperatures imposed by pasteurization and thermal treatments of sludge. Enteric viruses generally seem to be more tolerant of acid than alkaline conditions and to be most stable near pH 7, at which domestic wastewater and much sludge tend to be. There are still many unknowns in predicting the fate of viruses during sludge processing. More needs to be learned of the role of different classes of sludge soils in determining the stability of viruses during sludge treatment. More emphasis needs to be placed not only on means of testing sludge for viruses, but also on factors and components that govern the fate of viruses that are present. Alternatively, sludge treatments might be specified that impose one major condition (e.g., high temperature or high pH) that will essentially guarantee virus inactivation without regard for minor factors; this approach might prove costly. (See also W88-09463) (Lantz-PTT)
W88-09471

VIRAL ASPECTS OF APPLYING SLUDGES TO LAND,
Metropolitan Sanitary District of Greater Chicago, IL.
For primary bibliographic entry see Field 5E.
W88-09475

CORRECTIVE ACTION TECHNOLOGIES AND THEIR COST-EFFECTIVENESS,
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5G.
W88-09492

WASTEWATER TECHNOLOGY INNOVATION FOR THE YEAR 2000,
Brown and Caldwell, Walnut Creek, CA.
D. S. Parker.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 487-506, June 1988. 2 tab, 43 ref.

Descriptors: *Wastewater treatment, *Research priorities, *Biological wastewater treatment, Activated sludge process, Clarification, Trickling filters, Capital, Costs.

A renewal in national research in wastewater technology is proposed. Current EPA research expenditures in this field are 11% of those 10 years ago. Forecasts for municipal investment in wastewater treatment facilities are $91 billion by the year 2005. It is estimated that a national research program of $1 billion could save about $14 billion of this cost. Two case studies are presented. (1) An activated sludge secondary clarifier improvement resulted in a benefit-to-cost ratio for the research investment of 27:1. The research was funded by federal government in the late 1960s. It concerned enhancing flocculation of activated sludge solids before secondary sedimentation in a separate, mildly stirred basin located between the aeration basin and the secondary clarifier. (2) A trickling filter improvement produced a benefit-to-cost ratio of 30:1 for the original research. An eight-point program is presented for reinvigorating the national research program. It calls for public education in awareness for research need, funding for a national research program, consensus on research priorities, partnerships among various parties in research, attention to adaptation of theoretical ideas to full-scale plants, expansion of research activities beyond the university, shared risk taking, and the establishment of a national research foundation. Some research priorities include sedimentation tank design and operation, odor control, Nocardia foam control, small systems, digester foam problems, digester mixing design, public health and disinfection criteria, trickling filter process fundamentals, attached growth systems, and receiving water studies. (Cassar-PTT)
W88-09521

PRELIMINARY CONVERSION MECHANISMS IN ANAEROBIC DIGESTION OF BIOLOGICAL SLUDGES,
Clarkson Univ., Potsdam, NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5E.

W88-09525

CONTROL OF ANAEROBIC DIGESTION TOXICITY WITH POWDERED ACTIVATED CARBON,
Argonne National Lab., IL. Energy and Environmental Systems Div.
A. S. Ng, M. F. Torpy, and C. Rose.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 593-605, June 1988. 13 fig, 2 tab, 14 ref. Department of Energy Grant W-31-109-Eng-38.

Descriptors: *Wastewater treatment, *Digestion, *Anaerobic digestion, *Toxicity, *Biological wastewater treatment, Activated carbon, Chemical wastes, Industrial wastes, Organic compounds, Phenols, Dichlorophenol, Nitrophenol, Hexachloroethane, Nitrobenzene, Chlorophenol, Adsorption, Methanogenesis.

Powdered activated carbon was added to anaerobic digestion of wastes containing 50 to 500 mg/liter of organic compounds toxic to the digestion process. Carbon additions were zero, 500, 1000, 2000, and 4000 mg/liter. This treatment reduced or eliminated the inhibitory effects of the organic compounds. In a typical test nitrobenzene (50 mg/liter) with no added activated carbon produced <10 ml biogas after 2 days; 4000 mg/liter added activated carbon allowed generation of >70 ml biogas at 3 days, reaching a maximum of about 90 ml on the fourth day. Nitrobenzene is 80% inhibitory at 100 mg/liter. Other compounds tested (listed in decreasing order of toxicity) were 2,4-dichlorophenol, 2-nitrophenol, hexachloroethane, phenol, and 2-chlorophenol. (Cassar-PTT)
W88-09526

DYNAMIC ANAEROBIC FIXED-FILM REACTOR MODEL,
Ottawa Univ. (Ontario). Dept. of Civil Engineering.
R. L. Droste, and K. J. Kennedy.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 606-620, June 1988. 2 fig, 5 tab, 36 ref, 2 append.

Descriptors: *Fixed-film reactors, *Wastewater treatment, *Anaerobic digestion, *Biological wastewater treatment, Model studies.

A dynamic simulation model for an anaerobic downflow fixed-film reactor accounting for acidogens and methanogens in the mixed liquor and film phases, respectively, was developed. Growth and decay kinetics of each group of microorganisms in each phase were considered, along with their attachment and detachment rates to and from the film. The model was applied to four startup runs in which two substrate concentrations were used and two effluent volatile acids concentration ranges were maintained. A reasonably consistent set of model parameters was determined to apply to all runs, providing good verification of the model. (Author's abstract)
W88-09527

HYDRAULIC CHARACTERISTICS OF UPFLOW ANAEROBIC FILTERS,
EnviroSystems Supply, Inc., Fort Myers, FL.
H. W. Young, and J. C. Young.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 621-638, June 1988. 9 fig, 3 tab, 15 ref. EPA Grant R810528-010.

Descriptors: *Anaerobic filters, *Wastewater treatment, *Anaerobic digestion, *Biological wastewater treatment, *Hydraulic properties, Reynolds number, Tracers, Model studies, Flow characteristics, Plug flow, Filters.

Tracer studies were conducted to characterize the hydraulic behavior of upflow anaerobic filters at Reynolds numbers less than 25. Tests were conducted with three different sizes of cross-flow modular plastic media, providing a range of specific surface areas. Sections of this media were cut to fit a laboratory-scale reactor, and a radioactive tracer was used to assess the resident time distribution under different flow conditions typical of those found in full-scale systems. Tracer response curves were generated for various flow rates, and a computer model was developed to fit these curves. The best-fit model parameters indicated that the extent of plug flow was positively correlated with the Reynolds number within the range tested. Hydraulic dead space increased with increasing Reynolds number. An increase in the plug-flow behavior of the system also was associated with an increase in the specific surface area of the media. Gas bubbles passing through the media were found to produce complete mixing regardless of the media specific surface area. An agar coating used to simulate the presence of biological solids had little effect on the tracer response. (Author's abstract)
W88-09528

ANOXIC/OXIC ACTIVATED SLUDGE TREATMENT KINETICS OF CYANIDES AND PHENOLS,
Pennsylvania Univ., Philadelphia. Dept. of Systems Engineering.
W. K. Shieh, and D. J. Richards.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 639-654, June 1988. 9 fig, 2 tab, 26 ref, 2 append.

Descriptors: *Wastewater treatment, *Activated sludge process, *Biological wastewater treatment, *Industrial wastes, *Cyanides, *Phenols, Denitrification, Nitrification, Thiocyanates, Model studies, Kinetics, Chemical wastes.

The anoxic/oxic activated sludge treatment kinetics of cyanides (i.e., cyanide and thiocyanate) and phenols (i.e., phenol, cresols, and catechol) were studied. The Michaelis-Menten expression or its simplified forms were used to model the following microbial reactions associated with the process: (1) Anoxic/oxic total organic carbon (TOC) utilization; (2) anoxic denitrification; (3) nitrification; and (4) cyanide and thiocyanate utilization. The steady-state experimentation was performed to obtain experimental data for the validation of kinetic models and evaluation of kinetic coefficients. The results obtained indicate that all oxic microbial reactions occurring in an anoxic/oxic activated sludge process were not affected kinetically by the presence of the anoxic environment with high oxygen stress. As a result, the results collected from both conventional and anoxic/oxic activated sludge units exhibited identical kinetic patterns. Anoxic TOC utilization, anoxic denitrification, and nitrification reactions were described by zero-order expressions; oxic TOC utilization by first-order expressions, and cyanide and thiocyanate utilization rates by Michaelis-Menten expressions. The TOC requirements for denitrification including cell synthesis was approximately 2.2 g TOC/g NO2 + nitrate-N at mean cell residence time = 15 days, and it decreased to a constant level of about 1.2 g TOC/NO2 + nitrate-N as the mean cell residence time increased beyond 30 days. (Author's abstract)
W88-09529

BIOLOGICAL AERATED FILTER EVALUATION,
Washington Univ., Seattle. Dept. of Civil Engineering.
H. D. Stensel, R. C. Brenner, K. M. Lee, H. Melcer, and K. Rakness.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 655-671, June 1988. 6 fig, 5 tab, 16 ref, 2 append. EPA-University of Utah Cooperative Demonstration Agreement CS809217.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Aerated filters, *Aeration, *Filters, Oxygenation, Nitrification.

A two-cell, full-size biological aerated filter wastewater treatment unit was studied for two years. It had a nominal flow capacity of 1893 cu m/day. One cell was operated at a lower loading to accomplish combined biochemical oxygen demand (BOD) removal and nitrification, while the other cell was operated at a higher loading to achieve only BOD removal. The media size was found to be a critical design parameter for the system and was increased in each cell during the course of the study to allow 24-hour or longer run times before head loss levels required backwashing. The effluent BOD and suspended solids concentrations were related to the soluble BOD volumetric loading and reactor temperature. At relatively low organic and ammonium nitrogen loadings, up to 88% nitrification was achieved. Oxygen utilization efficiencies ranged from 5.0 to 7.7% for acceptable air application rates. Equations were developed to predict oxygen consumption and sludge production as a function of influent soluble BOD and suspended solids to influent total BOD ratios. The oxygen consumption was lower and sludge production was higher compared to conventional activated sludge treatment. (Cassar-PTT)
W88-09530

WOLLASTONITE AS ADSORBENT FOR REMOVAL OF FE(II) FROM WATER,
Banaras Hindu Univ., Varanasi (India). Inst. of Tech.
A. K. Singh, D. P. Singh, K. K. Panday, and V. N. Singh.
Journal of Chemical Technology and Biotechnology JCTBDC, Vol. 42, No. 1, p 39-49, 1988. 7 fig, 1 tab, 9 ref.

Descriptors: *Clay minerals, *Wollastonite, *Adsorbents, *Iron, *Water, *Wastewater treatment, Kinetics, Mass transfer, Diffusion coefficient, Isotherms, Langmuir isotherm, Performance evaluation, Pilot plants, Adsorption, Hydrogen ion concentration, Thermodynamics, Temperature, Water treatment.

Wollastonite was used as an adsorbent for the removal of Fe(II) at different experimental conditions. The extent of removal is favorable at low concentration and low temperature. Maximum adsorption was noted at pH 4.0. The batch adsorption kinetics has been described by a first order rate expression, and the surface mass transfer coefficients and diffusion coefficients have been calculated at different temperatures. The intraparticle transport of Fe(II) within the pores of wollastonite is found to be the rate limiting step. The applicability of the Langmuir isotherm for the present system has been tested at different temperatures. Thermodynamic parameters indicate the exothermic nature of Fe(II) adsorption on wollastonite. The variation of adsorption with pH has been explained on the basis of interaction of iron species with negatively charged constituents of adsorbent. (Author's abstract)
W88-09564

DETERMINATION OF ALKYLPHENOLS IN REFINERY EFFLUENTS BY LIQUID CHROMATOGRAPHY USING ELECTROCHEMICAL DETECTION,
Latrobe Univ., Bundoora (Australia).
For primary bibliographic entry see Field 5A.
W88-09596

LINEAR ALKYLBENZENE SULFONATES (LAS) IN SEWAGE SLUDGES, SOILS AND SEDIMENTS: ANALYTICAL DETERMINATION AND ENVIRONMENTAL SAFETY CONSIDERATIONS,
Procter and Gamble/ETC, Strombeek, Bever (Belgium).
For primary bibliographic entry see Field 5A.
W88-09618

CITY REDUCES SEWAGE TREATMENT COSTS BY 50 PERCENT,
T. L. Childers, and R. L. Ridings.
Public Works PUWOAH, Vol. 119, No. 5, p 69-70, May 1988.

Descriptors: *Wastewater treatment, *Municipal wastewater, *Cost analysis, Administrative decisions, Oklahoma City, Oklahoma, Land disposal, Operating costs, Contracts, Engineering, Design criteria.

Oklahoma City comprises 650 square miles, has 450,000 citizens, four major drainage basins with four sewage treatment plants discharging an average of 75 mgd of sewage, and 25,000 tons of sludge which is disposed of by land application on farmland. Program analysis of Oklahoma City's sewage treatment costs began with identification of full current costs including lift station, electrical, chemical, land application of sludge, and all overhead charges. In view of all evidence gathered, the following determinations were made: (1) that City Council establish a policy requiring competitive bidding of all future contracts for sewage treatment; (2) that the city adopt and implement formal procedures for obtaining 'value engineering' on major projects; (3) that the 'value engineering' firm may serve as the city's resident engineer to assure contract compliance by the successful bidder; (4) that annual surveys be made to determine if Oklahoma City costs are comparable to other cities; and (5) that a firm selected to perform 'value engineering' should not be eligible to bid or contract to construct the project they critique or design. Entrepreneurial city management can result in allowing the private sector to do what they do best--provide quality services at a lower cost to ratepayers. (Shidler-PTT)
W88-09650

IDENTIFICATION OF ASBESTOS AND GLASS FIBERS IN SEWAGE SLUDGES OF SMALL NEW YORK STATE CITIES,
Environmental Science and Engineering, Inc., Gainesville, FL.
For primary bibliographic entry see Field 5B.
W88-09656

HEAVY METALS REMOVAL FROM ANAEROBICALLY DIGESTED SLUDGE BY CHEMICAL AND MICROBIOLOGICAL METHODS,
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5E.
W88-09661

REVIEW OF DENITRIFICATION IN ON-SITE WASTEWATER TREATMENT SYSTEMS,
Madrid Univ. (Spain). Dept. of Chemical Engineering.
W. F. Ritter, and R. P. Eastburn.
Environmental Pollution, Vol. 51, No. 1, p 49-61, 1988. 38 ref.

Descriptors: *Denitrification, *Wastewater treatment, *Septic tanks, *Literature review, Load distribution, Soil types, Water table, Methanol, Carbon, Domestic wastes, Nitrogen removal.

The literature on denitrification and its relationship to on-site wastewater systems was reviewed. Denitrification is an important nitrogen removal mechanism in some alternative on-site wastewater systems. Nitrogen removal rates for conventional septic tank systems may vary from 0% to 35% but should be increased by pressure dosing. Denitrification rates for conventional on-site wastewater systems will depend upon loading rate, soil types and the height of the water table below the soil adsorption bed. Some alternative on-site wastewater systems may remove 70% to 80% of the nitrogen if a supplemental carbon source is used. Methanol and household wastes have been used as carbon sources. Crust formation in a soil adsorption bed may improve denitrification. (Author's abstract)
W88-09663

LIMNOLOGY OF A HYPERTROPHIC RESERVOIR STORING WASTEWATER EFFLUENT FOR AGRICULTURE AT KIBBUTZ NA'AN, ISRAEL,
Hebrew Univ., Jerusalem (Israel). Dept. of Zoology.
I. Dor, H. Schechter, and H. J. Bromley.
Hydrobiologia HYDRB8, Vol.150, No. 3, p 225-241, July 30, 1987. 16 fig, 6 tab, 22 ref.

Descriptors: *Eutrophication, *Limnology, *Hypertrophic reservoirs, *Wastewater lagoons, *Wastewater composition, *Dynamics, *Equilibrium, *Irrigation water, Storage reservoirs, Effluents, Secondary wastewater, Dissolved oxygen, Biochemical oxygen demand, Enrichment, Bacteria, Zooplankton, Israel.

The reservoir investigated collects domestic and agricultural effluents after primary and secondary treatment. Despite the high concentration of organic matter (mean BOD(5) = 60 mg/L), the reservoir does not deteriorate to produce obnoxious, anaerobic conditions. During a one year period, dissolved oxygen levels fluctuated widely but presented a long term dynamic stability, based on diffusion from the air during the winter mixing and on algal - bacterial - zooplankton equilibrium during the summer stagnation. The system, rich in organic and inorganic nutrients exhibited a much higher self-regulatory capability, than would be expected from its extreme enrichment. Under extremely hypertrophic conditions, both algae and bacteria are resistant to environmental fluctuations, closely coupled by competition (for organic molecules), mutual suppression (excretory products of both groups) and support (exchange of metabolites). At this stage, sensitivity of the ecosystem to the environmental factors greatly declines and dynamic equilibrium is supported chiefly by the biotic interactions between the dominant organisms. The reduced, specialized community seems to be more resistant to disturbance than the more diversified communities of clean water bodies. If this hypothesis is proved to be right, 'mixotrophic' conditions may be more favorable than purely hypertrophic ones. (Author's abstract)
W88-09695

PHOSPHORUS REMOVAL BY PURE AND MIXED CULTURES OF MICROORGANISM,
Tokyo Univ. (Japan). Inst. of Applied Microbiology.
Q. Ye, H. Ohtake, and K. Toda.
Journal of Fermentation Technology JFTED8, Vol. 66, No. 2, p 207-212, April 1988. 6 fig, 1 tab, 9 ref. Ministry of Education Grant 60030027.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Phosphorus removal, *Bacteria, Cultures, Microorganisms, Pseudomonas, Acinetobacter, Microbial degradation, Anaerobic digestion, Aerobic digestion, Activated sludge.

The ability to remove inorganic phosphate from synthetic wastewater was tested with 40 microbial strains and a strain of Pseudomonas aeruginosa was found to give good performance under aerobic conditions. However, phosphate removal under batch anaerobic/aerobic (A/O) treatment was not satisfactory in pure cultures of several strains including P. aeruginosa and Acinetobacter calcoaceticus, but the activated sludge from a plant with an A/O process almost depleted the phosphate. Mixed cultures of P. aeruginosa in the presence of facultatively-anaerobic strains isolated from the activated sludge showed enhanced phosphate removal. This suggests a symbiotic effect among microbial species on biological removal of inorganic phosphate in the A/O process. (Author's abstract)
W88-09838

PSYCHROPHILIC METHANE FERMENTATION OF EXCESS SLUDGE BY ENRICHMENT CULTURE,
Government Industrial Development Lab., Sapporo (Japan).
H. Matsuyama, and K. Izumi.
Journal of Fermentation Technology JFTED8, Vol. 66, No. 2, p 229-233, April 1988. 3 fig, 3 tab, 8 ref.

Descriptors: *Wastewater treatment, *Sludge digestion, *Moisture uptake, *Methane, *Fermentation, *Sludge treatment, Enrichment, Cultures, Food-processing wastes, Sludge seeding, Temperature effects, Comparison studies, Isolation, Anaerobic digestion.

The possibility of applying psychrophilic methane fermentation to the excess sludge produced from fish-processing wastewater treatment was evaluated. Three different kinds of seed sludge, named M seed sludge, K seed sludge, and KL seed sludge, were used for batch methane fermentation in Erlenmeyer flasks. M seed sludge was mesophilic, while the other two were prepared in a laboratory by soil collection to obtain a psychrophilic biological community. The effects of temperature on the total volume of biogas generated and on the rate of biogas generation were examined. The activity of K seed sludge with respect to gas yield at 15 C was found to be 1.6-fold higher than that of M seed sludge. Enrichment techniques were then used to accumulate psychrophilic bacteria in KL seed sludge, and the activity at 15 C increased by about two times due to these techniques. Comparison of the three kinds of seed sludge indicates that methane fermentation at low temperature may be feasible, and therefore further study to isolate the psychrophilic bacteria in anaerobic digestion is needed. (Author's abstract)
W88-09839

WATER QUALITY CHARACTERISTICS OF A SOUTHEAST FLORIDA SEWAGE TREATMENT AND BIOEFFECTS LABORATORY,
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
E. F. Corcoran, M. S. Brown, and S. C. Snedaker.
Florida Scientist, Environmental Chemistry FLSCA, Vol. 51, No. 1, p 49-55, Winter 1988. 4 tab, 17 ref. EPA Grants R-804749 and R-806307; Dames and Moore Contract 68-03-1706.

Descriptors: *Sewage Treatment and Bioeffects Laboratory, *Nutrients, *Water quality, *Wastewater, *Wastewater treatment, Organic compounds, *Analytical methods, Chemical analysis, Heavy metals, Sublethal effects, Aquatic animals, Effluents, Florida, Industrial wastewater, Nutrients, Performance evaluation, Pesticides, Organic compounds, Seawater.

A Sewage Treatment and Bioeffects Laboratory, located in southeast Florida, is described. Water quality characteristics of its seawater-diluted simulated wastewaters are compared with reported levels lethal to marine organisms. The laboratory processed incoming untreated (raw) wastewater and yielded six different effluents: primary settled, chemical flocculation, and activated sludge biological secondary settled, each chlorinated and nonchlorinated. Several water quality characteristics of the incoming untreated and biological secondary treated effluent were similar to those of a local sewage treatment plant using ocean outfall disposal. Effluent water quality was monitored for nutrients (NH3, NO2(-), NO3(-), and PO4(3-)), toxic metals (Cd, Cr, Cu, Pb, and Zn) and synthetic organics (chlorinated pesticides, aldrin, DDE, DDD, DDT, dieldrin, heptachlor epoxide, endrin; polychlorinated biphenyls, Aroclor 1016, 1242, 1254, 1260; and phthalic acid esters, butylbenzyl, butylglycolbutyl, di-butyl, di-ethylhexyl, di-ethyl, di-isobutyl and di-methyl phthalate) using standard analytical techniques. Estimated ambient concentrations of nutrients, toxic metals and synthetic organic compounds, after a 30-fold dilution of primary settled wastewater with seawater, fell below reported levels lethal to marine organisms. (Author's abstract)
W88-09950

BIOTRANSFORMATION OF DEHYDROABIETIC, ABIETIC, AND ISOPIMARIC ACIDS BY MORTIERELLA ISABELLINA IMMOBILIZED IN POLYURETHANE FOAM,
British Columbia Univ., Vancouver. Dept. of Chemistry.
J. P. Kutney, J. D. Berset, G. M. Hewitt, and M. Singh.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 4, p 1015-1022, April 1988. 6 fig, 5 tab, 11 ref.

Descriptors: *Mortierella isabellina, *Aquatic fungi, *Wastewater treatment, *Biodegradation, *Industrial Wastes, *Pulp wastes, *Dehydroabietic Acid, Biological wastewater treatment, Abietic Acid, Isopiramic Acid, *Detoxification, Microor-

ganisms, Metabolism, Enzymes, Resin acids, Pulp mills, Polyurethane foam.

Polyurethane foam supports immobilization of Mortierella isabellina (ATCC 38063), a zygomycete that hydroxylates and thereby detoxifies resin acids found in certain pulp mill effluents. The fungus becomes entrapped as it threads growing mycelia through the foam matrix. The tenacity of binding and the amount of biomass bound depend on initial spore numbers and nutrient concentration. Optimal dehydroabietic acid transformation occurs with early-stationary-phase foam-bound mycelia suspended in buffer at pH 6.5 to 8.5 with aeration >0.1 liter/liter-min and near a temperature maximum of 33 degrees. Neither a greater number of similarly loaded foam cubes nor a greater surface area for similar amounts of biomass increased transformation rates. Compared to free mycelial cultures, foam presence retards growth and decreases the rate of precursor transformation but does not alter the nature of the metabolites formed from dehydroabietic acid, abietic acid, or isopiramic acid. Diffusional barriers or binding of substrates in an inaccessible manner may cause the observed inhibitions. Overall, foam immobilization stabilizes enzymic activity and is a facile laboratory process with scaleup potential. (Author's abstract)
W88-09968

DESIGN OF SEWAGE LAGOONS USING STOCHASTIC STREAMFLOW SEQUENCES,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
J. F. Cruise, and V. P. Singh.
Journal of Water Resources Planning and Management JWPED5, Vol. 114, No. 3, p 353-364, May 1988. 3 fig, 16 ref, 2 append.

Descriptors: *Waste disposal, *Streamflow, *Wastewater lagoons, *Stochastic models, *Wastewater treatment, *Probabilistic processes, *Design criteria, Lagoons, Model Studies, Mathematical studies, Hydrographs.

A risk-based design procedure for hydrograph-controlled release sewage lagoons is derived. This procedure is based on a stochastic analysis of flood interarrival time, duration and volume. By modeling streamflow as a Poisson counting process. Stochastic sequences consisting of maximum interarrival times and minimum duration are constructed. These sequences are used as the basis for lagoon design by calculating their recurrence intervals based on the joint probability of exceedance of the components of the sequence. Sequences such as those derived here are shown to occur in nature. (Author's abstract)
W88-09986

EFFECTS OF PHOSPHORUS REMOVAL ON THE MAXIMAL ALGAL GROWTH IN BIOASSAY EXPERIMENTS WITH WATER FROM FOUR DUTCH LAKES,
Hoogheemraadschap van Rijnland, Leiden (Netherlands).
For primary bibliographic entry see Field 5G.
W88-09989

IMPACTS OF SEWAGE EFFLUENT ON TREE SURVIVAL, WATER QUALITY AND NUTRIENT REMOVAL IN COASTAL PLAIN SWAMPS,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
E. J. Kuenzler.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164090/AS. Price codes: A06 in paper copy; A01 in microfiche. North Carolina Water Resources Research Institute, Raleigh, Completion Report No. 235, (UNCWRRI-87-235), September 1987. 91 p, 25 fig, 7 tab, 69 ref. Contract No. 14-08-0001-G1243. Project No. USGS G1243-05.

Descriptors: *Wetlands, *Swamps, *Wastewater treatment, *Nutrient removal, *Nitrogen removal, *Phosphorus removal, Nitrogen, Phosphorus, Vegetation, Forest soils, Forests, North Carolina, Water pollution sources, Path of pollutants, Wastewater disposal.

An investigation was conducted of the impacts of sprayed municipal sewage on swamp tree survival and the effects of the swamp system on nutrient concentrations below the outfalls on two streams on the coastal plain of North Carolina. The swamp forest was clearly dominated by Nyssa aquatica; the other important species were N. sylvatica v. biflora, Populus heterophylla, Fraxinus spp., Taxodium distichum, Acer rubrum, and Liquidambar styraciflua. Effluent was discharged to one swamp stream by aerial spraying and to the other stream by way of a small ditch. Ninety-eight percent of the trees which were struck directly by the spray were dead within 18 months of the date spraying began. The sewage significantly increased the concentrations of chloride and nutrients at the outfalls. Nitrogen and phosphorus concentrations in stream water decreased below the outfalls on both streams. Although much of the concentration decrease could be attributed to dilution in winter, a simple graphical comparison of nutrient and chloride concentrations downstream showed net nutrient removal during most of the year. At times, however, there was net ammonium transfer to the water. Rates and fractions of nutrient net removal were calculated assuming that chloride is a conservative element in swamp water. Processing rates were fastest close below the outfalls, but slow rates over larger distances are probably also important for ultimate reduction of concentrations to background stream concentrations. Both swamp systems removed sufficient quantities of nitrogen and phosphorus within a few kilometers to account for virtually all of the sewage nutrient load to the swamps. (Lambert-UNC-WRRI)
W88-10001

FILTER BOTTOM CONSTRUCTION,
Roberts Filter Mfg. Co., Darby, PA.
R. L. Roberts.
U.S. Patent No. 4,619,765; October 28, 1986, 6 p, 4 fig. Official Gazette of the United States Patent Office, Vol 1071, No 4, p 1679, October 28, 1986.

Descriptors: *Patents, *Filters, *Wastewater treatment, *Water treatment, Filtration, Filter media, Backwash, Clogging, Permeability.

A multi-block filter bottom construction for water and wastewater filter systems contains filter blocks in parallel adjacent rows extending between the side walls of a filter. The blocks in each row are placed end-to-end and have upper and lower lateral sections extending horizontally between the end walls. The lateral sections are separated by horizontal partitions, but are interconnected by vertical ports extending through the partitions. One or more blocks in the construction are provided with a removable top wall having passages for communicating with the upper layer sections and fasteners for removably securing the top wall to the remainder of the block and for removal of the top wall without destroying or otherwise damaging the block. The multi-block filter bottom construction allows internal inspection without either removing or breaking the blocks. (Cremmins-AEPCO)
W88-10071

USE OF OPTIMIZATION MODELS IN THE DESIGN OF WASTEWATER TREATMENT SYSTEMS,
Missouri Univ.-Rolla. Dept. of Civil Engineering.
S. L. Liaw.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8708583. Ph.D Dissertation, 1986. 410 p, 46 fig, 47 tab, 71 ref, 5 append.

Descriptors: *Model studies, *Wastewater treatment, *Algorithms, *Optimization, *Mathematical models, Systems analysis, Design criteria, Synthesis, Wastewater facilities.

A bounded implicit enumeration (BIE) algorithm for wastewater treatment system synthesis models was developed and applied with the modeling to generate alternatives (MGA) technique to models for generating design alternatives. The wastewater treatment system synthesis models EXEC/OP and CAPDET were used for the BIE approach. The main program and subroutines of the models were modified to convert the original implicit or total enumeration algorithm to a bounded BIE algorithm. The generating and screening method and the efficient random generation method were added to the EXEC/OP model. A constraint method for generating noninferior designs was also included in the model. The BIE algorithm enables the system synthesis models to include more unit process options with different design parameters. It may be necessary to use fixed system optimization models to find the optimal value of the design parameters of a set of design alternatives generated by the system synthesis models. (Cremmins-AEPCO)
W88-10083

5E. Ultimate Disposal Of Wastes

STANDARDIZED SYSTEM FOR EVALUATING WASTE-DISPOSAL SITES,
H. E. LeGrand.
National Water Well Association, Worthington, Ohio. 1983. 49 p, 6 fig, 5 tab, 44 ref.

Descriptors: *Grounwater pollution potential, *Waste disposal, *Disposal sites, *Water quality control, Performance evaluation, Groundwater pollution, Standards, Hydraulic gradient, Permeability, Geohydrology, Aquifers, Path of pollutants, Leakage.

A numerical rating system is described for evaluating the potential of groundwater contamination from waste disposal sites. The system focuses on weighting four key geologic and hydrologic characteristics in the vicinity of contamination sources. The key parameters used are: (1) distance to a water supply; (2) depth to water table; (3) hydraulic gradient; and (4) permeability-sorption, as indicated by the geologic setting. Four digits and four additional letter codes concisely describe characteristics of a site for standardized interpretation and indicate the relative contamination potential. A site's hydrogeologic characteristics are identified on a scale of various aquifer sensitivities to contamination spread, and the particular waste's toxicity, concentration, volume and persistence are identified on a scale of severity of contaminants. These identified positions are integrated into a matrix in which the hazard potential is graphically displayed. The identified position in the matrix reveals the degree of seriousness. The probability of contamination can be determined by correlating a site's numerical description with a synthetic numerical standard in the matrix. Acceptance or rejection standards are suggested that are based first on the natural setting, and then on modifications to the site by specific engineering practices. The system: (1) optimizes existing data and provides a useful first-round evaluation of all types of leaks, spills and waste-disposal sites in relation to nearby groundwater and surface water supplies; (2) is generally consistent with various federal and state regulations and transcends these regulations to provide a suitable management-control mechanism for agencies and for owner/operators of waste facilities; and (3) provides a management-control mechanism through the stages of site evaluation, permit granting and monitoring for all categories of sites. (Lantz-PTT)
W88-08981

COMMENTS ON EPA'S EFFLUENT LIMITATION GUIDELINES FOR THE NONFERROUS METALS MANUFACTURING INDUSTRIES.
JACA Corp., Fort Washington, PA.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-232245. Price codes: A04 in paper copy, A01 in microfiche. January 1984. 85 p, 28 exhibits, 3 append. Small Business Administration Contract No. SBA-7161-0A-83.

Descriptors: *Regulations, *Nonferrous metals, *Water pollution control, *Effluent limitations, Aluminum, Copper, Lead, Silver, Wastewater disposal, Industrial wastes, Water quality standards, Cost analysis, Economic aspects, Toxic wastes, Water pollution prevention, Metals, Cost-benefit analysis, Cleanup Water Act.

The JACA Corporation analyzed the U. S. Environmental Protection Agency (EPA) proposed effluent limitation guidelines based on Clean Water Act authority for the manufacturers of eleven nonferrous metals and proposed recommendations that EPA should incorporate into the regulations. This report contains those recommendations for secondary aluminum, secondary copper, secondary lead, and secondary silver, as well as support documents associated with the guidelines for these four metals. The selection process for regulated pollutants and for control options is described. Control cost estimates are given along with an economic impact analysis for each of the four metals. A regulatory flexibility analysis and a cost effectiveness analysis are provided. JACA's recommendations were formulated on the basis of extensive reviews of the support documents, other docket records, public comments, discussions with the Office of Advocacy of the U. S. Small Business Administration, discussions with EPA personnel and trade association personnel, consultants, and JACA's own experience in regulatory analysis. (Geiger-PTT)
W88-09029

HANDBOOK OF HAZARDOUS WASTE MANAGEMENT FOR SMALL QUANTITY GENERATORS,
R. W. Phifer, and W. R. McTigue Jr.
Lewis Publishers, Chelsea, Michigan. 1988. 198 p.

Descriptors: *Hazardous wastes, *Waste management, *Waste disposal, *Toxic wastes, Regulations, Legal aspects, Liability, Solid waste disposal, Land disposal, Waste characteristics, Incineration, Chemical treatment, Political aspects, Landfills, Wastewater treatment, Social aspects.

This book provides small waste generators with the information needed to design a waste management program in compliance with current regulations. An introduction to the regulations (federal, state, and Environmental Protection Agency) is given along with a review of the types of waste generated by small quantity generators (solverts, acids and bases, heavy metals, pesticides, reactives, chemical reagents, and plating and heat treating wastes). The responsibilities of waste generators are outlined and the use of the code of federal regulations (titles 40 and 49) is described. The onsite storage and handling of hazardous wastes are discussed along with limiting liabilities and law enforcement. The proper management of laboratory waste is reviewed. Waste disposal options discussed include thermal treatment, chemical treatment, biological treatment, and land disposal. Trends in hazardous waste management that are discussed include political aspects, mobile and onsite treatment advances, research funding, waste minimization, and social aspects. (Geiger-PTT)
W88-09030

MEASUREMENT OF HYDROLYSIS RATE CONSTANTS FOR EVALUATION OF HAZARDOUS WASTE LAND DISPOSAL: VOLUME 2. DATA ON 54 CHEMICALS,
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5B.
W88-09031

ORGANIC COMPOUNDS AT THE SRP OLD BURIAL GROUND FOR LOW-LEVEL RADIOACTIVE WASTE,
Savannah River Lab., Aiken, SC.
For primary bibliographic entry see Field 5B.
W88-09035

STABILIZATION AND ISOLATION OF LOW-LEVEL WASTE DISPOSAL SITES,
Rockwell International, Richland, WA. Rockwell Hanford Operations.
S. J. Phillips, and T. W. Gilbert.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-008698. Price codes: A02 in paper copy, A01 in microfiche. April 1987. 18 p, 5 fig, 10 ref. Contract No. DE-AC06-77RL01030. Report No. RHO-RE-SA-170P.

Descriptors: *Radioactive wastes, *Toxic wastes, *Waste management, *Waste stabilization, *Waste dumps, *Grouting, Liquid wastes, Hazardous wastes, Wastewater treatment, Land disposal, Injection, Filtration, Gases, Cements.

Rockwell Hanford Operations is developing and testing equipment for stabilization and isolation of low-level radioactive liquid waste disposal sites. Stabilization and isolation are accomplished by a dynamic consolidation and particulate grout injection system. System equipment components include: a mobile grout plant for transport, mixing, and pumping of particulate grout; a vibratory hammer/extractor for consolidation of waste and backfill and for emplacement of the injector; a dynamic consolidation/injector probe for introducing grout into fill material; and an open-void surface injector that uses surface or subsurface mechanical or pneumatic packers and displacement gas filtration for introducing grout into disposal structure access piping. Treatment of a liquid-waste disposal site yields a physically stable, cementitious monolith. Additional testing and modification of this equipment for other applications to liquid waste disposal sites is in progress. (Author's abstract)
W88-09037

PHOSPHATE REMOVAL FROM EFFLUENTS,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5D.
W88-09048

SUPERFUND: CIVILIAN FEDERAL AGENCIES SLOW TO CLEAN UP HAZARDOUS WASTE.
General Accounting Office, Washington, DC. Resources, Community and Economic Development Div.
For primary bibliographic entry see Field 6E.
W88-09053

RISK ASSESSMENT AT HAZARDOUS WASTE SITES.
American Chemical Society, Washington, DC. ACS Symposium Series 204. Based on a symposium sponsored by the ACS Committee on Environmental Improvement at the 183rd Meeting of the American Chemical Society, Las Vegas, NV, March-April 1982. 1982. Edited by F.A. Long and Glenn E. Schweitzer. 128 p.

Descriptors: *Hazardous wastes, *Waste dumps, *Risks, *Public health, *Hazardous materials, Superfund Act, Land disposal, Waste disposal, Solid waste disposal, Legal aspects, Models, Evaluation, Water pollution effects, Toxicity, Cleanup operations.

Chapters in this book represent the final versions of the papers presented at the March 1982 symposium sponsored by the American Chemical Society on risk assessments at hazardous chemical waste sites. The first chapters present the problem: the history of the development of Superfund legislation and the arguments about the most appropriate approaches to risk assessments, specific cases of hazardous waste problems in Louisiana, the problems of Love Canal and their bearing on risk assessment, and the impacts on human health that can result from hazardous waste sites. The next broad topic of the symposium was the central problem of methodology of risk assessment. The practical problems that confront the field teams who examine specific chemical waste sites are: what to monitor, how to monitor, and how to have reasonable assurance of the reliability of the results of monitoring. A final chapter considers the problem of how to incorporate risk assessment into the regulatory process. (See W88-09057 thru W88-09064) (Geiger-PTT)
W88-09056

RISK ASSESSMENT UNDER THE REVISED NATIONAL CONTINGENCY PLAN OF SUPERFUND,
Kirkland and Ellis, Washington, DC.
E. B. Frost.
IN: Risk Assessment at Hazardous Waste Sites. American Chemical Society, Washington, DC. 1982. p 1-8, 12 ref.

Descriptors: *Risks, *Waste management, *Superfund Act, *Waste dumps, *Hazardous wastes, Waste disposal, Land disposal, Solid waste disposal, Water pollution prevention, Water pollution control, Research priorities, Models, Hazardous materials, Public health, Evaluation, Legal aspects.

The 1980 Congressional revision of the National Contingency Plan, now known as the Superfund Bill, is effectively a compromise between sharply differing positions. It calls for priority setting to identify the most hazardous sites, and this in turn requires explicit assessment of the risks from the sites. Hence risk assessment criteria must be established so that there can be developed a national priority list of the hazardous sites that require remedial action. EPA has adopted the Mitre Model for assessing the risks and ranking waste sites. There is some criticism of this model, and there are a number of as yet unanswered questions about its application. Formal cost/benefit analysis will not be used, and risk assessment will be on a case-by-case basis. EPA will thus be developing its knowledge base and procedures as it carries out the program. (See also W88-09056) (Author's abstract)
W88-09057

CASE STUDIES OF HAZARDOUS WASTE PROBLEMS IN LOUISIANA,
Louisiana Dept. of Natural Resources, Baton Rouge.
W. B. De Ville.
IN: Risk Assessment at Hazardous Waste Sites. American Chemical Society, Washington, DC. 1982. p 9-20.

Descriptors: *Hazardous wastes, *Waste management, *Waste disposal, *Louisiana, *Cleanup operations, Water pollution prevention, Hazardous materials, Decision making, Water pollution control, Legal aspects, Models, Case studies, Toxic wastes, Public policy.

Experience of Louisiana in dealing with hazardous waste management demonstrates the complexity of interactions among the technical, legal, economic and political elements of problems and actions. Current federal technical foundations for regulatory or Superfund decisions and actions provide only a rudimentary basis for program functions at the state level; this results in a tendency either to exaggerate or minimize the level of actual problems, and requires additional technical information to improve analysis of specific cases before action. This paper provides an analysis of the state's approaches to filling in gaps in the scientific and technical foundations for hazardous waste decisions by means of selected case histories. These case histories include: the approach to regulatory definitions of hazardous wastes, with emphasis on toxic properties; the regulatory approach to standards and criteria for facilities managing hazardous wastes; and development of cleanup responses to abandoned waste sites (with comments on the use of the Mitre Model for ranking such sites). The paper supports the conclusions that rational decisions can be made (though with some difficulty) in public policies related to the case histories, and an agenda for improving the scientific and technical components of hazardous waste and Superfund decisions is now apparent and can be suggested in broad outline. (See also W88-09056) (Author's abstract)
W88-09058

DETERMINING THE IMPACTS ON HUMAN HEALTH ATTRIBUTABLE TO HAZARDOUS WASTE SITES,
Centers for Disease Control, Atlanta, GA. Center for Environmental Health.
For primary bibliographic entry see Field 5C.
W88-09059

INDUSTRY'S GUIDELINES FOR RISK ASSESSMENT,
Shell Oil Co., Houston, TX.
R. H. Dreith.
IN: Risk Assessment at Hazardous Waste Sites. American Chemical Society, Washington, DC. 1982. p 45-53, 2 ref.

Descriptors: *Risks, *Waste dumps, *Hazardous wastes, *Waste dumps, *Standards, *California, Decision making, Evaluation, Industrial wastes, Waste disposal, Land disposal, Waste management, Cleanup operations, Public health, California, Shell Oil Company, Oil industry, Environmental effects.

In the absence of a consensus on absolute limits of risk, it is useful to have a goal-oriented risk assessment framework for decision making and response resource allocation. A four-step process is in use at Shell Oil Company to evaluate risks and define appropriate responses. The steps are: hazard identification, hazard evaluation, risk evaluation, and risk response. The first three steps amount to making a risk assessment, and the fourth step adds a response definition. A risk classification system setting high, low, and insignificant categories for risk reflecting unacceptable, variously acceptable and acceptable regions respectively are defined, and companion levels of response action are presented. An overview of a site evaluation experience in California is outlined. At the California waste dump site which had been used for the disposal of acidic materials from petroleum refineries, an early preliminary evaluation by federal, state, and local agencies was made to identify the nature of the materials in the site and the potential for an adverse effect. Then, with industry participation, a plan was followed to develop and then implement a detailed and comprehensive site evaluation. (See also W88-09056) (Author's abstract)
W88-09060

METHODOLOGY FOR ASSESSING UNCONTROLLED SITE PROBLEMS AT THE COUNTY LEVEL,
State Univ. of New York Coll. at Geneseo. Dept. of Geological Sciences.
R. A. Young, A. B. Nelson, and A. Hartshorn.
IN: Risk Assessment at Hazardous Waste Sites. American Chemical Society, Washington, DC. 1982. p 55-71, 4 fig, 4 tab, 3 ref.

Descriptors: *Hazardous wastes, *Waste dumps, *Risks, *Waste disposal, *Data acquisition, New York, Environmental impact statement, Hazardous materials, Public health, Aerial photography, Toxicity, Models, Urban areas, Environmental effects, Project planning, Evaluation, Leachates.

A comprehensive method to inventory inactive waste disposal sites should integrate all available historic, engineering, geologic, land use, water supply, and public agency or private company records in order to develop a complete and accurate site profile. Detailed information on site contents may not be available but areas of potential impact can be evaluated. Where people or drinking water supplies are affected, further investigation is indicated. Historic aerial photographs provide the accuracy and documentation required to compile a precise record of site boundaries, points of access, and adjacent land use. Engineering borings for construction projects in the vicinity of suspected sites are integrated with geologic information to construct reasonable hydrogeologic models to evaluate potential leachate impact on water wells or nearby inhabitants. Sites are systematically ranked using matrices with appropriate variables, such as geology, land use, or distance to water wells. This kind of an evaluation is a necessary step in the prioritization of sites where little is known about contents and where numbers of sites preclude a comprehensive drilling and testing program. The Monroe County experience indicates that a well-designed study provides a conservative estimate of the number of large dump sites that require further consideration. This study provided a comprehensive, fifty-year inventory of all potentially significant sites in a large urban area (Rochester, New York). (See also W88-09056) (Author's abstract)
W88-09061

MONITORING TO SUPPORT RISK ASSESSMENTS AT HAZARDOUS WASTE SITES,
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 7A.
W88-09062

CURRENTLY AVAILABLE GEOPHYSICAL METHODS FOR USE IN HAZARDOUS WASTE SITE INVESTIGATIONS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W88-09063

INCORPORATING RISK ASSESSMENT INTO THE RESOURCE CONSERVATION AND RECOVERY ACT REGULATORY PROCESS,
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 6E.
W88-09064

FATIGUE-CRACK PROPAGATION BEHAVIOR OF ASTM A27 CAST STEEL IN SIMULATED HANFORD GROUNDWATER,
Westinghouse Hanford Co., Richland, WA.
For primary bibliographic entry see Field 8G.
W88-09085

REMOTE SENSING AT SAVANNAH RIVER,
For primary bibliographic entry see Field 7B.
W88-09087

HAZARDOUS WASTE: QUESTIONS AND ISSUES FROM THE FIELD,
Environmental Protection Agency, Boston, MA. Region I.
H. P. Hynes.
IN: Environmental Sampling for Hazardous Wastes. American Chemical Society, Washington, DC. 1984. p 1-5.

Descriptors: *Hazardous materials, *Waste disposal, *Water pollution control, *Project planning, Indicators, Fate of pollutants, Path of pollutants, Data interpretation, Sampling, Statistical methods, Case studies, On-site investigations, Groundwater pollution.

The issues relevant to all hazardous waste site investigations, remedial actions, and ongoing field surveillance of cleaned sites were discussed with emphasis on some questions of field engineers and scientists concerning the number of samples, length of the sampling period, frequency of sampling, indicator parameters and field screening techniques, and methods of quantitative analysis. The cost-effective, logical, and efficient concept of selecting indicator contaminants in environmental sampling was detailed. The regulations require that groundwater quality parameters, indicators of groundwater contamination, pH, specific conductance, total organic halogen and total organic carbon, be measured in the aquifer below a surface impoundment, landfill or land treatment facility for hazardous wastes to establish an initial background concentration. The measurements are then repeated on a specified schedule to show changes in the parameters. Two examples, taken from case studies, were presented in which the significance and meaning of the field investigation results depended entirely on the design of the environmental sampling programs. In one case the selection of indicator compounds was arbitrary and potentially misleading since the chemical and physical properties of all the contaminating compounds present were not considered. In a second, the statistical techniques applied to the data for reporting results and for comparison with standards and future data were not discussed; a common omission. It is suggested that a systematic approach to the design of field sampling, to the selection of compounds for analysis, and to the methods for interpretation of the analytical data be improved. (See also W88-09120) (Wood-PTT)
W88-09121

ASSESSING CYANIDE CONTAMINATION FROM AN ALUMINUM SMELTER,
Washington State Dept. of Ecology, Olympia.
For primary bibliographic entry see Field 7A.
W88-09123

FIRST EPA SUPERFUND CUTOFF WALL: DESIGN AND SPECIFICATIONS,
Goldberg-Zoino and Associates, Inc., Newton Upper Falls, MA.
For primary bibliographic entry see Field 5G.
W88-09131

ENVIROWALL VERTICAL CUTOFF BARRIER,
For primary bibliographic entry see Field 5G.
W88-09132

ISOLATION OF CONTAMINATED GROUND WATER BY SLURRY-INDUCED GROUND DISPLACEMENT,
For primary bibliographic entry see Field 5G.
W88-09133

USE OF ANALYTICAL MODELS FOR EVALUATING CORRECTIVE ACTIONS AT HAZARDOUS WASTE SITES,
GeoTrans, Inc., Reston, VA.
For primary bibliographic entry see Field 7C.
W88-09140

ASSESSMENT OF GROUND-WATER CONTAMINATION AND REMEDIAL ACTION FOR A HAZARDOUS WASTE FACILITY IN THE GULF COAST,
Ecology and Environment, Inc., Kansas City, KS.
For primary bibliographic entry see Field 5G.
W88-09145

CONTAMINATED GROUND-WATER RECOVERY SYSTEM ANALYSIS, DESIGN AND CONSTRUCTION AT A WASTE MANAGEMENT FACILITY LOCATED IN A GULF COASTAL PLAIN,
For primary bibliographic entry see Field 5G.
W88-09146

DESIGN OF COST-EFFECTIVE CHEMICAL MONITORING PROGRAMS FOR LAND DISPOSAL FACILITIES,
For primary bibliographic entry see Field 7A.
W88-09152

WILL MY MONITORING WELLS SURVIVE DOWN THERE: DESIGN AND INSTALLATION TECHNIQUES FOR HAZARDOUS WASTE STUDIES,
Western Water Consultants, Inc., Sheridan, WY.
For primary bibliographic entry see Field 7B.
W88-09155

APPLICATION OF GEOPHYSICAL TECHNIQUES AS A SITE SCREENING PROCEDURE AT HAZARDOUS WASTE SITES,
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 7B.
W88-09166

APPROACH TO DRILLING AND INSTALLATION OF GROUND-WATER MONITORING WELLS ON HAZARDOUS WASTE SITES,
For primary bibliographic entry see Field 7A.
W88-09167

VOLATILIZATION OF ORGANIC COMPOUNDS FROM UNCONFINED AQUIFERS,
Massachusetts Inst. of Tech., Cambridge. Water Resources and Environmental Engineering Div.
For primary bibliographic entry see Field 5B.
W88-09168

HYDROGEOLOGIC INVESTIGATIONS OF FAILURE MECHANISMS AND MIGRATION OF ORGANIC CHEMICALS AT WILSONVILLE, ILLINOIS,
T. M. Johnson, R. A. Griffin, K. Cartwright, L. R. Follmer, and B. L. Herzog.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 413-420, 5 fig, 2 tab, 3 ref.

Descriptors: *Water pollution treatment, *Groundwater pollution, *Aquifer, *Monitoring, *Cleanup operations, *Waste disposal, *Hazardous materials, Population exposure, Installation, Site characterization, Organic compounds, Sampling, Wells, Leachates, Linings, Construction, Acid mine drainage, Soil contamination, Illinois, Glacial aquifers, Geohydrology.

This paper describes an in-progress study to exhume and remove wastes at a hazardous waste disposal facility near Wilsonville, Ill. The scope of the work includes site characterization, measurement of organic chemical effects, clay liner construction, assessing acid mine drainage, and observation and documentation of the condition of the trench covers and drums and wastes. The major efforts of the project at the time of writing were installation of wells and the collection of samples outside of the disposal pits. Soil borings and installation of monitoring wells were completed. Analyses of water, leachate and soil samples were continuing. Preliminary examination of samples form the soil borings and observations made in backhoe pits on and around the site indicate that sandy layers within the clay till are not continuous and thus cannot account entirely for the observed contaminant migration. (See also W88-09129) (Friedmann-PTT)
W88-09177

RECOVERY OF COAL GASIFICATION WASTES: AN INNOVATIVE APPROACH,
Pennsylvania Power and Light Co., Allentown. Environmental Management Div.
For primary bibliographic entry see Field 5G.
W88-09180

CONTAMINATED GROUND-WATER CONTAINMENT/TREATMENT SYSTEM AT THE NORTHWEST BOUNDARY, ROCKY MOUNTAIN ARSENAL, COLORADO.
Corps of Engineers, Omaha, NE.
For primary bibliographic entry see Field 5G.
W88-09182

EVOLUTION AND ADEQUACY OF GROUND WATER MONITORING NETWORKS AT HAZARDOUS WASTE DISPOSAL FACILITIES IN ILLINOIS,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 7A.
W88-09292

SUB-LINER GROUND WATER MONITORING AT A LARGE LINED LANDFILL,
Golder Associates, Mississauga (Ontario).
For primary bibliographic entry see Field 7A.
W88-09301

GRAVITY FLOW HORIZONTAL DRAINS UTILIZED FOR IN-PLACE REMEDIATION,
Blasland and Bouck Engineering, Syracuse, NY.
For primary bibliographic entry see Field 5G.
W88-09319

MODELING REMEDIAL ACTIONS AT UNCONTROLLED HAZARDOUS WASTE SITES,
Anderson-Nichols and Co., Inc., Palo Alto, CA.
For primary bibliographic entry see Field 5G.
W88-09358

REMEDIAL INVESTIGATIONS/FEASIBILITY STUDIES UNDER SUPERFUND,
Camp, Dresser and McKee, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5G.
W88-09377

U.S. EPA RESEARCH ON IN-SITU TREATMENT TECHNOLOGY,
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
For primary bibliographic entry see Field 5D.
W88-09380

SUBSURFACE WASTEWATER INJECTION: THE TECHNOLOGY OF INJECTING WASTEWATER INTO DEEP WELLS FOR DISPOSAL,
Missouri Univ.-Rolla.
D. L. Warner, and J. H. Lehr.
Premier Press, Berkeley, California. 1981. 344 p.

Descriptors: *Wastewater disposal, *Injection wells, *Groundwater pollution, Waste disposal, Geohydrology, Design standards, Monitoring, Water quality control.

Groundwater has become an increasingly important natural resource. At the same time the need for deep underground disposal of wastewater through injection wells has steadily grown. The design, construction, operation, and abandonment of subsurface wastewater injection systems are described. Local geologic and hydrologic characteristics of the injection and confining intervals are considered along with the physical, chemical, and biological compatability of the receiving zone with the wastewater to be injected. Design and construction aspects of injection wells are presented along with recommended preinjection testing, operating procedures, and emergency precautions. Monitoring requirements are discussed, in addition to records maintenance and proper well abandonment procedures. (Lantz-PTT)
W88-09386

SAMPLING AND VARIABILITY IN SOILS AND SOLID WASTES,
For primary bibliographic entry see Field 5A.
W88-09431

SAMPLING AND ANALYSIS OF HAZARDOUS AND INDUSTRIAL WASTES: SPECIAL QUALITY ASSURANCE AND QUALITY CONTROL CONSIDERATIONS,
University of Wyoming Research Corp., Laramie. Western Research Inst.
For primary bibliographic entry see Field 5A.
W88-09433

HUMAN VIRUSES IN SEDIMENTS, SLUDGES, AND SOILS.
For primary bibliographic entry see Field 5B.
W88-09463

PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEDIMENT, SLUDGES, AND SOILS,
Houston Univ., TX. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-09464

TRANSPORT AND FATE OF VIRUSES IN SOILS: FIELD STUDIES,
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
For primary bibliographic entry see Field 5B.
W88-09473

VIRAL ASPECTS OF APPLYING SLUDGES TO LAND,
Metropolitan Sanitary District of Greater Chicago, IL.
J. J. Bertucci, S. J. Sedita, and C. Lue-Hing.
IN: In: Human Viruses in Sediments, Sludges, and Soils. CRC Press, Inc., Boca Raton, Florida. p 179-195, 3 fig, 11 tab, 45 ref.

Descriptors: *Wastewater treatment, *Land disposal, *Sludges, *Viruses, *Risk assessment, Public health, Case studies, Field tests, Path of pollutants, Land application, Literature review, Sludge disposal, Epidemiology, Model studies, Monitoring, Surveys, Serology.

The construction of a quantitative concept or model to assess the risk from human viruses in municipal sludge applied to land is very difficult. Six large-scale projects are discussed as case studies; all used some combination of environmental virus monitoring, health questionnaires, and serological surveys to detect viruses in the environment or human virus infections related to the land application of municipal sludges. The results from field studies are negative with respect to a virus-related hazard to humans. A recent comprehensive literature review and analysis of the overall health effects associated with the land application of sludge points out some possible routes of human virus transmission in such operations, but give no evidence of actual transmission. The preponderance of negative findings from field and epidemiological studies prevents, at this time, the construction of a realistic model for estimating the possible risk to humans from viruses applied to land. The best information currently available does not indicate the existence of an assessable risk. Despite the current lack of evidence of a virus problem associated with land application of sludge, recent and upcoming advancements in virology will give environmental virologists additional matters to study. (See also W88-09463) (Lantz-PTT)
W88-09475

USE OF REMOTE SENSING, GEOPHYSICAL AND SOIL GAS TECHNIQUES TO LOCATE MONITORING WELLS AT HAZARDOUS WASTES SITES IN NEW HAMPSHIRE,
New Hampshire Dept. of Environmental Services, Concord.
For primary bibliographic entry see Field 7A.
W88-09509

PRELIMINARY CONVERSION MECHANISMS IN ANAEROBIC DIGESTION OF BIOLOGICAL SLUDGES,
Clarkson Univ., Potsdam, NY. Dept. of Civil and Environmental Engineering.
S. G. Pavlostathis, and J. M. Gossett.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 575-605, June 1988. 6 fig, 5 tab, 29 ref, 3 append. EPA Grant R 809500-01-0.

Descriptors: *Sludge digestion, *Wastewater treatment, *Anaerobic digestion, *Biological wastewater treatment, Digestion.

Anaerobic digester performance was evaluated in the laboratory with special emphasis on the study of preliminary conversion steps in sludges containing intact viable cells. The sludge was generated from totally biological wastewater. The COD fraction in the activated sludge contained >80% particulate protein, about 12% carbohydrates, and about 6% lipids. Autoclaved (lysed) activated sludge was separated into solids and soluble fractions for individual treatment. Ultimate digestibility (total COD reduction) was as follows: intact sludge, 61.5%; autoclaved sludge (total), 72.2%; autoclaved sludge solids, 69.5%; and autoclaved sludge, soluble fraction, 92.5%. Results showed that hydrolysis of particulate protein was the major, rate-limiting step in the digestion of biological solids. The percent COD destruction was independent of influent concentration, supporting the use of a first-order rate to describe hydrolysis. (Cassar-PTT)
W88-09525

PRESENCE AND PERSISTENCE OF LISTERIA MONOCYTOGENES IN FOOD AND WATER,
Georgia Experiment Station, Griffin.
For primary bibliographic entry see Field 5B.
W88-09563

SOIL CONTAMINATION BY SOME ORGANIC MICROPOLLUTANTS RELATED TO SEWAGE SLUDGE SPREADING,

Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. du Genie de l'Environment.
P. Dierckxsens, and J. Tarradellas.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 1+2, p 143-159, January 1987. 8 fig, 5 tab, 37 ref, append. Swiss National Fund for Scientific Research PNR 7B program.

Descriptors: *Soil contamination, *Organic compounds, *Path of pollutants, *Sludge disposal, *Land application, Sludge, Phenols, Manure, Fertilizers, Polychlorinated biphenyls, Hydrocarbons.

Soil contaminated by four different micro pollutant classes due to sewage sludge spreading. The soil under research shows an accumulation of low molecular weight polycyclic aromatic hydrocarbons and polychlorinated biphenyls, diethylhexyl phthalate and 4-nonylphenol just after spreading. But one month later, the concentration of these micropollutant groups fall to the concentration detected just before the sludge spreading. As far as the soil concentration is concerned, only PAHs and PCBs are precipitation dependent. Some test plots which were enriched for 10 yrs with fertilizers, pig-dung or sewage sludges show only an increase of the PAH concentrations of the plots amended with sludges. In the same way, the sewage sludge is chiefly responsible for the increase of PCBs in the soils, but pig-dung seems to contain quantities of these micropollutants which have to be taken into consideration. (Author's abstract)
W88-09577

FATE OF ATRAZINE AND TRIFLURALIN FROM AN INDUSTRIAL WASTE DUMPING AT THE LLOBREGAT RIVER: PRESENCE IN FISH, RAW AND FINISHED WATER,
Instituto de Quimica Bio-Organica, Barcelona (Spain).
For primary bibliographic entry see Field 5A.
W88-09600

GEOMEMBRANES FOR MUNICIPAL SOLID WASTE LANDFILLS,
Gundle Lining Systems, Inc., Houston, TX.
M. C. Mathieson, and M. W. Cadwallader.
Public Works PUWOAH, Vol. 119, No. 5, p 80-81, May 1988. 1 tab.

Descriptors: *Solid waste disposal, *Impervious membranes, *Linings, *Municipal wastes, *Landfills, Groundwater pollution, Industrial wastes, Hazardous materials, Permeability, Florida.

In its effort to protect groundwater, the EPA is requiring increased and more diversified liner layering for hazardous waste landfills and surface impoundments. Many of the chemicals that cause industrial solid wastes to be classified as hazardous are also present in municipal solid wastes. Synthetic landfill liners are highly attractive because of their negligible permeability and good chemical resistance. A 12-acre high-density-polyethylene-lined landfill for Leon County, Florida, is described. (Shidler-PTT)
W88-09651

HEAVY METALS REMOVAL FROM ANAEROBICALLY DIGESTED SLUDGE BY CHEMICAL AND MICROBIOLOGICAL METHODS,
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
R. D. Tyagi, D. Couillard, and F. Tran.
Environmental Pollution, Vol. 50, No. 4, p 295-316, 1988. 7 tab, 7 fig, 25 ref. Natural Sciences and Engineering Research Council of Canada grants A3711 and A4984 and the Ministere de l'Education of the Province of Quebec grant FCAR 87-AS-2462.

Descriptors: *Waste disposal, *Waste treatment, *Heavy metals, *Digested sludge, *Anaerobic digestion, *Chemical degradation, *Microbiological degradation, *Leaching, Sludge solids, Hydrogen ion concentration, Acidification, Copper, Solubility, Economic efficiency.

Metal removal from anaerobically digested sludge was studied by chemical treatment and microbial leaching processes in laboratory reactors. The removal of metals increases with decreased sludge solid concentration and pH. In the acid treatment process, a pH of 1.5 was required to reduce the copper concentration in the sludge to an acceptable level. In the microbial processes, mixed culture gave a 10% better solubilization of metals than in single culture (T. ferroxidans). The acid requirement was lower for the microbial process. As a result, the cost of sludge treatment in terms of chemicals was found to be decreased by 80% in microbial leaching. (Author's abstract)
W88-09661

NITRATE IN WATERS FROM SEWAGE-SLUDGE AMENDED LYSIMETERS,
For primary bibliographic entry see Field 5B.
W88-09662

EFFECT OF GAMMA-IRRADIATED SLUDGE ON THE GROWTH AND YIELD OF RICE (ORYZA SATIVA L. VAR. GR-3),
Baroda Univ. (India). Dept. of Microbiology.
G. A. Pandya, L. Prakash, P. Devasia, and V. V. Modi.
Environmental Pollution, Vol. 51, No. 1, p 63-73, 1988. 2 fig, 4 tab, 27 ref.

Descriptors: *Disinfection, *Plant growth, *Crop yield, *Gamma irradiation, *Sludge utilization, *Rice, *Sludge, *Fertilization, *Irradiation, *Growth media, Root development, Chlorophyll, Yield, Growth.

The effects of gamma-irradiated sludge on the growth and yield of rice (Oryza sativa L. var. GR-3) in pot cultures have been studied. Compared to plants grown only in soil, shoot length, root length, fresh weight, dry weight, total proteins, total soluble sugars, starch and chlorophyll content of plants grown in soil supplemented with unirradiated or gamma-irradiated sludge were found to be significantly increased. Irradiation of sludge significantly stimulated the linear growth of shoot and root systems as well as fresh and dry weights of plants, compared to those grown in soil containing unirradiated sludge. There was also an improvement in the grain yield (weight of seed) when plants were grown in soil supplemented with irradiated sludge. The results obtained suggest that the gamma-irradiated sewage sludge can be beneficially recycled for agricultural uses. (Author's abstract)
W88-09664

POULTRY WASTE LAGOON SEDIMENT AS A SOURCE OF CALCIUM FOR LAYING HENS,
Florida Univ., Gainesville. Dept. of Poultry Science.
R. D. Miles, D. R. Sloan, R. H. Harms, and J. E. Marion.
Florida Scientist FLSCA, Vol. 49, No. 2, p 122-125, Spring 1986. 3 tab, 6 ref.

Descriptors: *Recycling, *Waste recovery, *Calcium, *Calcium carbonate, *Cycling nutrients, *Poultry, *Wastewater lagoons, *Diets, Bottom sediments, Excretion, Sludge disposal, Chemical analysis.

An experiment was conducted to determine if calcium in the sediment, which accumulates in poultry waste lagoons, could be used in laying hen diets as a source of calcium for egg production. The sediment used for this study was obtained from two locations within a lagoon, located on a layer farm in central Florida. The farm had been operational for approximately 10 years. Two hundred laying hens, in peak production, were fed either a corn-soybean meal basal diet or the basal diet supplemented with the lagoon sediment. Based on the sediment's nutrient analysis it was added to the diet at a level to furnish approximately 50% of the total calcium. No significant differences were observed between treatments in egg production, feed consumption, feed efficiency, egg weight, or egg specific gravity. Thus, it was concluded that poultry lagoon sediment can furnish calcium for laying hen feeds. (Author's abstract)
W88-09676

PATHWAY OF TRACE ELEMENTS DURING OIL SHALE COMBUSTION - A CLUE TO THEIR AVAILABILITY FOR LEACHING PROCESSES,
Geological Survey of Israel, Jerusalem.
For primary bibliographic entry see Field 5B.
W88-09704

PSYCHROPHILIC METHANE FERMENTATION OF EXCESS SLUDGE BY ENRICHMENT CULTURE,
Government Industrial Development Lab., Sapporo (Japan).
For primary bibliographic entry see Field 5D.
W88-09839

PREDICTION OF TIME VARIATION IN WATER AND CHLORIDE PROFILES IN A SOIL SUBJECT TO CROPPING AND ANNUAL APPLICATION OF SEWAGE SLUDGE,
National Inst. for Environmental Studies, Tsukuba (Japan). Systems Analysis and Planning Div.
S. Otoma, and T. Kuboi.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 1-17, May 1988. 10 fig, 1 tab, 23 ref.

Descriptors: *Sludge disposal, *Soil contamination, *Chlorides, *Cropping, *Path of pollutants, *Solute transport, Simulation, Hydrology, Geohydrology, Waste disposal, Spatial distribution, Chemical analysis, Mathematical studies, Rainfall, Grasses, Growth, Model studies, Soil-water-plant relationships, Soil water.

A numerical model of discrete type was applied for simulating water and chloride movement through the upper 100 cm of unsaturated soils treated with sewage sludge and planted with Italian ryegrass. The model simulation indicated that the time required for washing out the chloride from the soil depended on the amount of precipitation rather than the number of repetitions of sludge application. When the precipitation exceeded the sum of the evaporation and the water taken up by the plant, the distribution of the chloride concentration reached an equilibrium within several years. When the precipitation was less than the sum of the evaporation and the water taken up, the concentration of chloride in soil increased annually and the water deficit was critical during the period of active plant growth. A part of the chloride transported by the unsteady flow of water reached the soil layers at a depth below 100 cm, even though the net amount of water leached was equal to or less than zero. (Author's abstract)
W88-09911

PERMEABILITY AND COMPRESSIBILITY OF SLURRIES FROM SEEPAGE-INDUCED CONSOLIDATION,
Universidad Politecnica de Cataluna, Barcelona (Spain).
A. Huerta, G. A. Kriegsmann, and R. J. Krizek.
Journal of Geotechnical Engineering JGEND2, Vol. 114, No. 5, p 614-627, May 1988. 5 fig., 10 ref., 1 append.

Descriptors: *Slurries, *Clays, *Seepage, *Mine wastes, *Waste disposal, *Mathematical models, Disposal capacity, Permeability, Soil types, Piezometric head, Compressibility.

A one-dimensional mathematical model based on finite-strain theory is developed to solve the problem of seepage-induced consolidation in sedimented slurries or very soft clays. The direct solution employs known or assumed material property relationships to determine the final thickness of a soft sediment subjected to a constant piezometric head. It is useful for predicting the capacity of a disposal area and the time-dependent improvement in material properties. Alternatively, the inverse solution utilizes final settlement and steady-state flow data from laboratory or field tests to deduce permeability and compressibility relationships for soft sediments. This approach is especially helpful in the

case of permeability determinations because it avoids some of the major problems associated with permeability testing of such materials. The resulting model shows that the coefficient of permeability influences both the time to reach the steady-state condition and the nature of the steady-state condition itself. An illustrative example is presented wherein date from a series of tests on a kaolinite slurry are used to establish material property relationships that are then used to predict the response of other tests on the same soil under different conditions. (Author's abstract)
W88-09958

EFFECTS OF SEWAGE DUMPING ON MACROBENTHIC INVERTEBRATES IN THE JORDAN GULF OF AQABA, RED SEA,
Jordanian Marine Science Station, Aqaba.
For primary bibliographic entry see Field 5C.
W88-09996

UNDERGROUND STORAGE TANK DISPOSAL: ALTERNATIVES, ECONOMICS, AND ENVIRONMENTAL COSTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
J. E. Robinson, D. W. Scott, W. Knocke, and W. D. Conn.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-186077/AS. Price codes: A04 in paper copy; A01 in microfiche. Virginia Water Resources Research Center Blacksburg, Bulletin 160, February 1988. 53 p, 6 tab, 54 ref, 3 append.

Descriptors: *Underground storage tanks, *Waste disposal, *Costs, *Virginia, *Hazardous waste disposal, Abandonment, Environmental impacts, Resource Conservation and Recovery Act, Comprehensive emergency response, Compensation, Liability Act, Petroleum products.

Alternative technologies were examined for the disposal of disused underground storage tanks (UST) that once contained petroleum products or other hazardous chemicals and the effects of hazardous waste laws on disposal are discussed. Disposal options for the large population of old vessels are considered in terms of currently required and available technologies, the benefits and problems associated with various strategies, and the means available to a tankowner for utilizing these options through either a full or partial contracting of commercial services. Actual disposal costs charged by firms offering the service in or near Virginia were compared and the environmental impacts associated with cleaning wastes and tanks discharged according to each strategy are addressed. Additional information about pertinent regulations and the characteristics of the national UST populations are provided in the Appendices. (USGS)
W88-10036

FINANCIAL RESPONSIBILITY PROVISIONS FOR UNDERGROUND TANKS IN VIRGINIA,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5G.
W88-10037

5F. Water Treatment and Quality Alteration

PLANNING FOR AN INDIVIDUAL WATER SYSTEM.
American Association for Vocational Instructional Materials, Athens, Georgia. 1982. 160 p. Edited by J. Howard Turner.

Descriptors: *Water supply development, *Management planning, *Water supply, Water demand, Water use, Disinfection, Water treatment, Pumping, Pipes.

Methods are given for planning a safe and adequate water supply for the person who has the responsibility of providing a water system for a suburban home, vacation home, farm or ranch. The general objectives are to help a student become proficient in the following jobs: (1) Determining how much water is needed for persons, livestock, domestic animals, and other uses such as a swimming pool and lawn and garden irrigation; (2) Determining the amount of available water; (3) Determining if the available water is safe; (4) Protecting water sources from pollution; (5) Disinfecting water; (6) Conditioning water; (7) Selecting a pump; (8) Selecting a water storage; (9) Providing housing for the pump and water storage; (10) Selecting the piping system; and (11) Selecting the proper wiring. (Lantz-PTT)
W88-08973

WATER SYSTEMS HANDBOOK: A COMPLETE TEXT ON PRIVATE WATER SYSTEMS - THEIR DESIGN, OPERATION AND MAINTENANCE.
Water Systems Council, Chicago, IL.
Water Systems Council, Chicago, Illinois. 1987. 106 p, 85 fig, 6 tab.

Descriptors: *Water supply, *Design criteria, *Maintenance, *Water conveyance, *Handbooks, *Groundwater management, Pumps, Groundwater quality, Costs, Economic aspects, Pipes, Groundwater budget.

The modern groundwater system is both flexible and functional. A variety of pumps are available, to lift water from all sizes and types of wells, from the shallowest to the deepest. The systems are made automatic and dependable by many types of controls and accessories. Additional equipment can be added to the system for treatment where required. It is estimated that 97% of all fresh water available in the nation at any time is groundwater. Groundwater, having been filtered by the underground formations through which it passes, has a degree of purity seldom attained by surface waters. While its mineral content varies, depending on the geology of the area, the minerals are harmless and add to taste; where too strong, the minerals may be reduce by softeners, filters and chlorinators. A major advantage of private wells and water systems using groundwater supply is low cost. Except in heavily populated areas, it is less expensive to install and maintain a private system than it is to pay the significant piping and operating costs of a central system - such as a rural water district. This handbook explains how private groundwater systems are designed and operated. (Lantz-PTT)
W88-08984

1987 ANNUAL BOOK OF ASTM STANDARDS,
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 7B.
W88-08988

INNOVATIVE BIOLOGICAL TREATMENT OF CONTAMINATED GROUNDWATER,
DETOX, Inc., Dayton, OH.
For primary bibliographic entry see Field 5G.
W88-08992

SMALL SCALE WATER TREATMENT SYSTEMS FOR REMEDIATING CONTAMINATED GROUND WATER,
Geraghty and Miller, Inc., Oak Ridge, TN.
For primary bibliographic entry see Field 5G.
W88-08993

REMEDIATION OF HYDROCARBON CONTAMINATION WITHIN TRENCH-FILL MATERIALS ASSOCIATED WITH A 48-INCH WATER MAIN,
WESTEC Services, Inc., San Diego, CA.
For primary bibliographic entry see Field 5G.
W88-08999

ORGANOHALOGEN FORMATION TREATMENT AND CONTROL,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5B.
W88-09049

TREATMENT TECHNOLOGY FOR REMOVAL OF DISSOLVED GASOLINE COMPONENTS FROM GROUND WATER,
For primary bibliographic entry see Field 5D.
W88-09136

WATER SUPPLY CONTAMINATION CLEAN-UP IN MASSACHUSETTS,
Massachusetts Dept. of Environmental Quality Engineering, Boston.
For primary bibliographic entry see Field 5G.
W88-09321

EFFECTIVENESS OF AIR STRIPPING VERSUS ACTIVATED CARBON FOR REMOVAL OF DBCP, EDB, AND TCP AT ULTRA-LOW CONCENTRATIONS,
GMP Associates, Inc., Honolulu, HI.
L. A. Mainsfield, W. A. Guirguis, K. Hayashida, and P. B. Melnyk.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 510-535. 6 fig, 11 tab, 4 ref.

Descriptors: *Water treatment, *Activated carbon, *Air stripping, *Adsorption, *Chlorinated hydrocarbons, *Organic compounds, *Groundwater pollution, *Groundwater management, Groundwater monitoring, Monitoring wells, Detection limits, Water quality, Aquifers, Design criteria, Economic aspects, Groundwater, Hawaii, Cost analysis, Adsorption.

Traces of the halogenated hydrocarbons, Ethylene Dibromide (EDB), dibromochloropropane (DBCP) and trichloropropane (TCP) were detected in certain potable water wells at two sites in Hawaii. One location (Site I) displayed detectable concentrations of DBCP and TCP at levels up to 75 parts-per-trillion (ppt) and 2.5 parts-per-billion (ppb), respectively; while the contaminants found at the other location (Site II) were EDB, at levels reaching 90 ppt and TCP at levels of 0.25 ppb. Three processes investigated were: adsorption by granular activated carbon and desorption by a packed tower and a cooling tower. A granular activated carbon pilot unit, operated at Site I over a period of two months, demonstrated the effectiveness of adsorption to remove contaminants to completely non-detectable concentrations. Carbon usages were determined in the laboratory by the Dynamic Filtration Test for waters from Sites I and II and were, respectively: 23 and 36 pounds per one million gallons treated. The ability of desorption with the packed tower to reduce contaminant concentrations to or below their accepted detection limits, i.e., 20 ppt for DBCP and EDB, and 200 ppt for TCP; was witnessed through pilot tests at both sites. Sufficient data were collected during these tests to permit calculation of mass transfer coefficients for each contaminant which were subsequently used in preparing a preliminary design for full scale system. Desorption was also found to be effective with a cooling tower. Treatment costs were determined based on a preliminary design prepared for each process at Sites I and II. At Site I, these costs were: $0.26, $0.22 and $0.27 per thousand gallons, for activated carbon, packed tower and cooling tower treatment, respectively, and at Site II, costs were $0.22 and $0.16 per thousand gallons treated for activated carbon and packed tower treatment. Adsorption with activated carbon became the preferred treatment process at both sites, after comparison of treatment costs and relative performance. (See also W88-09283) (Author's abstract)
W88-09323

RESIDENTIAL SCALE RADON REMOVAL SYSTEM,
North East Environmental Products, Inc., Lebanon, NH.

B. L. Lamarre.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 559-573, 7 fig, 4 ref.

Descriptors: *Radon radioisotopes, *Groundwater pollution, *Drinking water, *Water treatment, Public health, Iron, Calcium, Manganese, Path of pollutants, Fouling, New Hampshire, Cost analysis, Case studies.

Radioactive radon gas accumulation in residential structures has received a great deal of attention in the popular press and in some of the trade journals over the last few years. The EPA and several states are currently conducting studies and surveys to assess the extent and severity of the radon contamination problem. The current status of the radon problem and the mechanisms for radon contamination of homes are summarized. North East Environmental Products, Inc. is conducting extensive field research into the treatment of residential water supplies using air stripping techniques. The results of two case studies conducted in New Hampshire are described. The case studies include the basic design of the air strippers used in the studies, a discussion of the parameters studied, and a summary of the critical performance results. As with other air stripping applications, iron, manganese and calcium can cause fouling of the column and downstream piping. A discussion of these operational considerations is presented along with methods for turning these problems into beneficial treatment opportunities. An approximate cost comparison of the available treatment alternatives is given. Application of air stripping technology to radon removal from small community water supplies is also viable. Appropriate design parameters for radon removal in community water supply systems are presented. (See also W88-09477) (Author's abstract)
W88-09508

USING UNDERGROUND ANTHRACITE MINE POOLS FOR MUNICIPAL WATER SUPPLIES: CASE STUDY - MT. CARMEL, PENNSYLVANIA,
Benatec Associates, Inc., Harrisburg, PA.
For primary bibliographic entry see Field 3C.
W88-09519

DEVELOPMENT OF COST EQUATIONS FOR GAC TREATMENT SYSTEMS,
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
J. Q. Adams, and R. M. Clark.
Journal of Environmental Engineering JOEDDU, Vol. 114, No. 3, p 672-688, June 1988. 1 fig, 5 tab, 11 ref, 2 append.

Descriptors: *Granulated activated carbon, *Water treatment, *Activated carbon, *Organic compounds, Cost analysis, Capital costs, Drinking water.

The use of granular activated carbon (GAC) as a broad spectrum adsorbent in the treatment of drinking water has been shown to be effective in removing or reducing concentrations of specific organics and total organic carbon. Much concern has been expressed, however, regarding the cost of GAC systems, and therefore several studies have been conducted to develop cost-estimating equations for system components. Early cost studies are based on design and not on as-built plants. A comparison between costs from some recently completed field projects and costs estimated from these conceptual design studies has resulted in a reevaluation of the early estimates. Most estimates are close to the actual costs derived from the field projects. However, by combining data from the field projects and design studies, an updated set of cost estimating equations has been developed for GAC treatment systems. These new equations can be used to estimate capital costs and individual operation and maintenance cost components. (Author's abstract)
W88-09531

METERING UTILITY SERVICES: EVALUATION AND MAINTENANCE,
California Univ., Davis. Dept. of Civil Engineering.
J. R. Lund.
Water Resources Research WRERAO, Vol. 24, No. 6, p 802-816, June 1988. 5 fig, 6 tab, 64 ref.

Descriptors: *Water metering, *Water costs, *Utilities, Maintenance, Scheduling, Pricing, Economic aspects, Cost-benefit analysis.

Operations research methods are proposed for evaluating customer metering in terms of maximizing economic efficiency, utility profits, and economic equity. Established methods were modified and improved for assessing the conservation benefits of metering. Three domestic water supply situations were explored using the method: Perth, Australia (economic feasibility of metering); Worchester, England (optimality of metering); and Seattle, Washington (the question of continuation of metering). In Perth metering was justified as profitable and economically efficient partly because of very high unmetered consumption. In Worchester household consumption was low and estimates of reduction in use were also low; in this region metering was found to be neither efficient nor profitable to the utility. In Seattle, where universal metering is practiced, analysis showed that metering was neither profitable nor economically efficient. Methods were also applied to the problems of inefficient meters and meter maintenance. The minimum present value cost approach was applied to two common meter maintenance strategies: (1) the simple change-out period strategy, where meters on all connections are changed periodically on a block-by-block basis and (2) scheduling of meter repairs by individual connection, based on flow and age. The second method was found superior to the first, saving as much as $3.40 per meter per year. (Cassar-PTT)
W88-09539

WOLLASTONITE AS ADSORBENT FOR REMOVAL OF FE(II) FROM WATER,
Banaras Hindu Univ., Varanasi (India). Inst. of Tech.
For primary bibliographic entry see Field 5D.
W88-09564

POLAROGRAPHIC DETERMINATION OF LEAD IN DRINKING WATER SAMPLES OF WESTERN U. P. DISTRICTS WITH 3-HYDROXYPYRIDINE-2-THIOL,
M.S. Coll., Saharanpur (India). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W88-09574

GC/MS, HPLC AND FAB MASS SPECTROPHOTOMETRIC ANALYSIS OF ORGANIC MICROPOLLUTANTS IN BARCELONA'S WATER SUPPLY,
Instituto de Quimica Bio-Organica, Barcelona (Spain). Lab. d'Espectrometria de Masses.
For primary bibliographic entry see Field 5A.
W88-09583

INVESTIGATION OF A TOXIC WATER-BLOOM OF MICROCYSTIS AERUGINOSA (CYANOPHYCEAE) IN LAKE AKERSVATN, NORWAY,
Norges Veterinaerhoegskole, Oslo. Dept. of Food Hygiene.
For primary bibliographic entry see Field 5C.
W88-09625

EXPERIENCES WITH TREATMENT FOR VOLATILE ORGANIC CONTAMINANTS,
Dufresne-Henry, Inc., Westford, MA.
G. R. Allan.
Journal of the New England Water Works Association JNEWA6, Vol. 102, No. 1, p 13-21, March 1988. 1 fig, 4 tab.

Descriptors: *Volatile organic contaminants, *Water treatment, *Organic compounds, *Groundwater pollution, *Aeration, *Activated carbon, *Adsorption, Volatility, Pollutants, Air temperature, Bacteria, Iron, Costs, Economic feasibility.

Three different communities in Massachusetts found that their groundwater supply had become contaminated with volatile organic chemicals (VOCs). The effectiveness of both aeration and carbon adsorption designs were compared as to the efficiency of VOC removal. Operational considerations such as air temperature, possible bacteriological contamination, iron plugging, desorption of granular activated carbon, and costs are noted. The conclusion: Removal of VOCs from a groundwater supply is feasible and economical. (Author's abstract)
W88-09644

DEVELOPING DYNAMIC TOOLS FOR WATER DISTRIBUTION SYSTEM MANAGEMENT,
Boston Water and Sewer Commission, MA.
L. Blank, and S. Shea.
Journal of the New England Water Works Association JNEWA6, Vol. 102, No. 1, p 22-28, March 1988.

Descriptors: *Water distribution, *Management planning, *Computers, Boston, History, Water demand, Hydraulics, Capital, Surveys, Maps, Operating policies, Dynamic programming, Systems analysis, Hydraulic models, Maintenance.

A two-and-a-half-year study of the Boston water-distribution system was undertaken. The result was a comprehensive report about such diverse subjects as system history, the actual and projected demand pattern, system hydraulics, and a proposed capital-needs program. Inventories, maps, and standard operating procedures were prepared. Computers were used extensively in the study and then integrated into the ongoing water department operations. The paper highlights that part of the report about the hydraulic analysis and the development of a 'work-order system' for maintenance. (Author's abstract)
W88-09645

PILOT PLANT EXPERIENCES IN WALLINGFORD, CONNECTICUT,
Whitman and Howard, Inc., Wellesley, MA.
O. E. Poirier.
Journal of the New England Water Works Association JNEWA6, Vol. 102, No. 1, p 29-47, March 1988. 13 fig, 4 tab.

Descriptors: *Water treatment facilities, *Pilot plants, Connecticut, Reservoirs, Evaluation, Turbidity, Organic compounds, Color, Chemical treatment, Filter media, Ozonation, Oxidation, Filtration, Pretreatment of water, Water treatment.

A pilot-plant study was undertaken at a Connecticut water-treatment plant as a basis for recommending improvements and expansion to upgrade the facility at MacKenzie Reservoir. Among other things the pilot study was to evaluate the use of a 'Super Pulsator' to reduce turbidity, total trihalomethanes, and color; to select treatment chemicals; to evaluate different filter media; and to investigate ozone and chlorine dioxide as oxidizers. The results of the pilot-plant work resulted in a recommendation to build a filtration plant at Paug Pond, a different source altogether, and replenishing the water in Paug Pond with pretreated water from MacKenzie Reservoir. (Author's abstract)
W88-09646

PHOTOLYTIC DEGRADATION OF TRACE AMOUNTS OF DIBROMO-1,2-PROPANE IN WATER: THE INFLUENCE OF HYDROGEN PEROXIDE (DEGRADATION PAR PHOTOLYSE DU DIBROMO-1,2 PROPANE PRESENT A L'ETAT DE TRACES DANS L'EAU: INFLUENCE DU PEROXYDE D'HYDROGENE),
Universite de Toulon et du Var, La Garde (France). Lab. de Chimie Appliquee.
J. C. Milano, and J. L. Vernet.
Chemosphere CMSHAF, Vol. 17, No. 5, p 963-

971, 1988. 1 fig, 1 tab, 38 ref (no English summary).

Descriptors: *Organohalogens, *Photolysis, *Water treatment, *Photolytic degradation, *Dibromopropane, *Chemical degradation, Chemical reactions, Organic compounds, Light effects, Pesticides.

Photolysis of dibromo-1,2-propane, dissolved at trace levels in pure water and in the presence of hydrogen peroxide, was examined. Reactions occurring in quartz and pyrex tubes are described and the reaction products are characterized. It is shown that the action of hydrogen peroxide in the presence of UV radiation has specific application in the area of purification of water contaminated by pesticides and other organohalogen pollutants. (Friedmann-PTT)
W88-09655

WATER TANK RECYCLED INTO A PUMP STATION - IN-HOUSE,
M. R. Newman.
Public Works PUWOAH, Vol. 119, No. 6, p 73-75, June 1988.

Descriptors: *Water distribution, *Pumping plants, *Water tanks, *Utility expansion, Urbanization, Cost analysis, Storage tanks, Florida, Remote control, Water demand.

Rapid economic growth in Southwest Florida during the early 1980's generated demands on the Collier County water distribution system and resulted in low pressures and reduced storage capacities. In 1985-86 a plant was developed for the South County Distribution Area that included a primary repump station and 2.0 MG storage tank and the upgrading of existing facilities on the Isle of Capri. In addition to increased storage capacity the facilities had to be designed to withstand severe weather (i.e., hurricanes, flooding, salt water corrosion), and be easy to expand. As an economy measure an existing 0.25 MG storage tank was converted into the repump facility. The system was operable by telemetry at a plant nine miles away with both automatic and manual remote pump controls and a chlorine control system that allowed for a constant residual leaving the facility. An exterior berm and landscaping was added to enhance the appearance. In order to meet cost requirements the facilities were constructed by in-house personnel. The system has expanded rapidly and anticipates keeping pace with the county's growth. (White-Reimer-PTT)
W88-09657

CONTROL OF PEAK WATER DEMANDS,
For primary bibliographic entry see Field 3D.
W88-09658

CADD - GENERATED WATER SYSTEM ATLAS OFFERS FLEXIBILITY,
For primary bibliographic entry see Field 6B.
W88-09659

ORGANIC CONTAMINANT REMOVAL BY COAGULATION AND RELATED PROCESS COMBINATIONS,
Kansas Univ., Lawrence. Dept. of Civil Engineering.
S. J. Randtke.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 5, p 40-56, May 1988. 14 fig, 6 tab, 143 ref.

Descriptors: *Drinking water, *Water treatment, *Coagulation, *Organic compounds, Literature review, Water supply, Process control, Pretreatment of water, Filtration, Activated carbon, Adsorption.

Work done over the past few decades to understand the removal of organic contaminants by the coagulation process, alone and in combination with other processes is summarized. Published data demonstrate that coagulation can substantially reduce the concentration of certain organic contaminants found in drinking-water supplies, and that an understanding of the fundamental mechanisms by which coagulation removes organic contaminants facilitates qualitative prediction of the types of contaminants likely to be removed and the effects of process-control variables. Data also demonstrate that removal of organic contaminants by coagulation can be influenced by other processes, such as pre-ozonation, and that coagulation can influence the removal of organic contaminants by subsequent treatment processes, such as filtration and activated-carbon adsorption. (Author's abstract)
W88-09833

ADVANCED OXIDATION PROCESSES FOR TREATING GROUNDWATER CONTAMINATED WITH TCE AND PCE: LABORATORY STUDIES,
California Univ., Los Angeles. School of Public Health.
W. H. Glaze, and J.-W. Kang.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 5, p 57-63, May 1988. 7 fig, 5 tab, 19 ref. EPA Cooperative Agreement CR-813188.

Descriptors: *Water treatment, *Groundwater pollution, *Chlorinated hydrocarbons, *Ozone, *Chemical treatment, *Oxidation process, Experimental data, Hydrogen peroxide, Mass transfer, Bicarbonates, Water softening.

Oxidation of trichloroethylene (TCE) and tetrachloroethylene (PCE) with various dosages of ozone, or ozone plus hydrogen peroxide, was studied in laboratory experiments. The results show that hydrogen peroxide accelerates the oxidation of TCE and PCE by ozone. At peroxide-to-ozone dosage ratios of >0.7 (w/w), the process appears to be mass-transfer limited. High levels of bicarbonate ion in the groundwater significantly decreased the efficiency of TCE and PCE removal by the ozone-peroxide system, suggesting that softening prior to oxidation may improve the process. (See also W88-09835) (Author's abstract)
W88-09834

ADVANCED OXIDATION PROCESSES FOR TREATING GROUNDWATER CONTAMINATED WITH TCE AND PCE: PILOT-SCALE EVALUATIONS,
Montgomery (James M.), Inc., Pasadena, CA.
E. M. Aieta, K. M. Reagan, J. S. Lang, L. McReynolds, and J.-W. Kang.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 5, p 64-72, May 1988. 11 fig, 10 tab, 23 ref.

Descriptors: *Water treatment, *Groundwater pollution, *Chlorinated hydrocarbons, *Chemical treatment, *Oxidation process, *Ozone, Pilot plants, Hydrogen peroxide, Mass transfer, Comparison studies, Cost analysis.

A pilot-scale evaluation was conducted of an advanced oxidation process that utilizes hydrogen peroxide and ozone. Treatment efficiency was determined as a function of the peroxide-to-ozone dosage ratio. The ozone mass-transfer characteristics of the process were also investigated. Comparison with other treatment technologies indicates that advanced oxidation can be a cost-effective treatment process for controlling the common chlorinated organics found in groundwater. (See also W88-09834) (Author's abstract)
W88-09835

USING GAC TO REMOVE VOCS FROM AIR STRIPPER OFF-GAS,
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
J. C. Crittenden, R. D. Cortright, B. Rick, S.-R. Tang, and D. Perram.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 5, p 73-84, May 1988. 7 fig, 11 tab, 32 ref. AWWA Research Foundation Contract 83-84.

Descriptors: *Water treatment, *Activated Carbon, *Organic compounds, *Volatile organic compounds, *Oxidation process, Chlorinated hydrocarbons, Adsorption, Kinetics, Regeneration, Steam, Cost analysis, Economic aspects.

The technical and economic feasibility of treating air-stripper off-gas with granular activated carbon (GAC) was evaluated. For dichloroethene and trichloroethene, air stripping followed by off-gas GAC treatment was shown to be very effective and economical compared with aqueous-phase GAC treatment, with GAC usage rates for gas-phase adsorption being less than one-half those for aqueous-phase adsorption. Because gas-phase adsorption kinetics are much faster than liquid-phase kinetics, the required bed depth and diameter are much smaller for gas-phase beds. Steam regeneration was found to be ineffective for regeneration of gas-phase GAC at low concentrations. (Author's abstract)
W88-09836

GRANULAR ACTIVATED CARBON FOR CONTROLLING THMS,
Environmental Protection Agency, Cincinnati, OH.
B. W. Lykins, R. M. Clark, and J. Q. Adams.
Journal of the American Water Works Association JAWWA5, Vol. 80, No. 5, p 85-92, May 1988. 13 fig, 4 tab, 19 ref.

Descriptors: *Water treatment, *Activated carbon, *Organic compounds, *Trihalomethanes, Disinfection, Water quality standards, Trace levels, Cost analysis, Operating costs.

Suggested reduction of the maximum contaminant level for trihalomethanes (THMs) could force many utilities to change disinfectants or to alter treatment processes. Faced with this possibility, more utilities are considering granular activated carbon (GAC) for trace organics removal. However, GAC will not be effective for all situations. This article presents performance and cost data, collected from five sites, for the removal of THMs, their precursors, and surrogates. The cost of GAC treatment varied for each location examined, with 14.9 cents/1000 gal being the lower cost for a 25-microgram/L total THM goal and 98 cents/1000 gal the highest cost. For a 50-microgram/L total THM goal, the lower cost was 13.8 cents/1000 gal and the highest cost was 82.9 cents/1000 gal. This cost would have to be evaluated with other treatment alternatives for controlling THMs, taking into account disinfection by-products other than THMs and any other detrimental effects. (Shidler-PTT)
W88-09837

VARIATIONS IN THE FLUORIDE LEVELS OF DRINKING WATER IN SOUTH AFRICA: IMPLICATIONS FOR FLUORIDE SUPPLEMENTATION,
Stellenbosch Univ. (South Africa). Faculty of Dentistry.
S. R. Grobler, and A. G. Dreyer.
South Africa Medical Journal, Vol. 73, No. 4, p 217-219, February 20, 1988.

Descriptors: *Water treatment, *Fluoridation, *Seasonal variation, *Fluorides, *Drinking water, *Water supply, Electrodes, Water quality, South Africa.

The range of fluoride levels in the drinking water of cities and villages of South Africa was determined during the transition from a very dry (1983) to a wet (1984/1985) period. The combination fluoride ion selective electrode was employed for the determination of the fluoride concentration. It was found that fluoride levels in drinking water changed for 93% of the cities and villages studied during the period 1983-1985. Furthermore, it became clear that when the water volume of the supplying source increased, the fluoride level decreased significantly ($P < 0.01$). Boreholes showed significantly higher fluoride levels ($P < 0.01$) than rivers or dams. The impact of the variation in drinking water fluoride concentrations on supplementary fluoride dosage is discussed and recommendations made. (Author's abstract)

W88-09900

MYCOBACTERIA IN PUBLIC WATER SUPPLIES: COMPARATIVE RESISTANCE TO CHLORINE,
Harvard Medical School, Boston, MA. Dept. of Anaesthesia.
P. A. Pelletier, G. C. du Moulin, and K. D. Stottmeier.
Microbiological Sciences, Vol. 5, No. 5, p 147-148, May 1988. 1 tab, 12 ref. EPA Grant CR-812787-01-0.

Descriptors: *Disinfection, *Mycobacteria, *Water supply systems, *Water quality, *Chlorination, *Water treatment, Population exposure, Temperature effects, Bacteria, Public health.

The isolation of mycobacteria from municipal and hospital water supplies prompted an investigation of the susceptibility of environmental and clinical isolates of mycobacteria other than Mycobacterium tuberculosis and Mycobacterium bovis to free chlorine. Experiments revealed that free chlorine concentrations of 1.0 mg/L eliminated 100,000 c.f.u. of the mycobacterial strains tested within 8 hours of exposure, whereas a concentration of 0.15 mg/L had virtually no bacteriocidal effect. Free chlorine residual levels of 0.1 mg/L or less, depending on the water temperature, within Boston, suggest that current disinfection procedures may not be adequate for effective control of potentially pathogenic mycobacteria in public water supply systems serving a population with increased risk factors. (Author's abstract)
W88-09951

ASSESSMENT AND CONTROL OF RISKS FROM LEGIONNAIRES DISEASE,
J. M. Sykes, and A. M. Brazier.
Annals of Occupational Hygiene AOHYA3, Vol. 32, No. 1, p 63-67, 1988. 2 ref.

Descriptors: *Legionella pneumophila, *Bacteria, *Legionnaires disease, *Risk assessment, *Water pollution sources, *Water pollution prevention, *Water quality control, *Human diseases, *Public health, Public policy, United Kingdom.

The fact that Legionella is ubiquitous in nature poses problems for assessment and control. The relevant sections of the Health and Safety Work Act, 1974, require one to do what is reasonably practicable, a duty which entails a balance between the quantum of risk and the cost of avoiding it. The paper explains the Health and Safety Executive's attitude towards the assessment of potential risk situation, the control of factors which promote multiplication and the design, maintenance and operation of systems which may disseminate respirable aerosols. The joint microbiological and engineering approach, which this attitude entails, is designed to minimize the incidence of a disease which has attracted much public interest. (Author's abstract)
W88-09962

WATER DISTRIBUTION RELIABILITY: ANALYTICAL METHODS,
Massachusetts Inst. of Tech., Cambridge. Operations Research Center.
J. M. Wagner, U. Shamir, and D. H. Marks.
Journal of Water Resources Planning and Management JWPED5, Vol. 114, No. 3, p 253-275, May 1988. 9 fig, 8 tab, 44 ref, append.

Descriptors: *Water distribution, *Model studies, *Reliability, *Performance evaluation, Probabilistic process, *Mathematical analysis, Reachability, Algorithms.

Probabilistic reliability measures for the performance of water distribution networks are developed and analytical methods for their computation explained. The paper begins with a review of reliability considerations and measures for water supply systems, making use of similar notions in other fields. It classifies reliability analyses according to the level of detail with which the water system is modeled, and then concentrates on methods relevant to networks. Two probabilistic measures, reachability (connection of a specific demand node to at least one source) and connectivity, are explored for use in water distribution systems. Two algorithms for their computation are presented, one for series-parallel networks and one for general networks. These measures are computed for two systems, each with ten nodes. Additionally, the probability that a given point receives sufficient supply is proposed for use as a reliability measure. For the calculation of this measure, an algorithm is provided that combines a capacitated network algorithm with a method to efficiently search through network configurations involving multiple link failures. This measure is calculated for the two sample systems. (See also W88-09981) (Author's abstract)
W88-09980

WATER DISTRIBUTION RELIABILITY: SIMULATION METHODS,
Massachusetts Inst. of Tech., Cambridge. Operations Research Center.
J. M. Wagner, U. Shamir, and D.H. Marks.
Journal of Water Resources Planning and Management JWPED5, Vol. 114, No. 3, p 276-294, May 1988. 7 fig, 8 tab, 12 ref, 3 append. NSF Grant CEE 8408369.

Descriptors: *Water distribution, *Simulation analysis, *Pumps, *Pipes, Mathematical studies, Computers, Failures.

A simulation is presented as a method for analyzing the reliability of water distribution networks. For this simulation, the distribution system is modeled as a network whose pipes and pumps are subject to failure. Nodes are targeted to receive a given supply at a given head. If this head is not attainable, supply at the node is reduced. Pumps and pipes fail randomly, according to probability distributions with user-specified parameters. Several reliability measures are estimated with this simulation. Confidence intervals are also supplied for some of these reliability measures. Simulation results are presented for a small network (ten nodes) and a larger network (sixteen nodes). Simulation enables computation of a much broader class of reliability measures than do analytical methods, but it requires considerably more computer time and its results are less easy to generalize. It is therefore recommended that analytical and simulation methods be used together when assessing the reliability of a system and considering improvements. (See also W88-09980) (Author's abstract)
W88-09981

MODELING DISTRIBUTION-SYSTEM WATER QUALITY: DYNAMIC APPROACH,
Grayman (Walter M.), Concinnati, OH.
W. M. Grayman, R. M. Clark, and R. M. Males.
Journal of Water Resources Planning and Management JWPED5, Vol. 114, No. 3, p 295-312, May 1988, 13 fig, 10 ref, append.

Descriptors: *Water distribution, *Water duality, *Drinking water, *Water quality management, *Computer models, *Model studies, Mathematical studies, Algorithm, Monitoring.

Interest is growing in determining the quality variations that exist in drinking water distribution systems. This paper is dedicated to understanding distribution-system quality issues and to the development of a model that will enhance this understanding. A dynamic algorithm that can be used to predict water quality variations is described in this paper. Determination of the blending of flows from separate sources, tracing of transient concentrations in the system, and establishment of a compliance monitoring system are only a few of the potential uses of such a model. The model has been implemented on a microcomputer and applied to the North Penn Water Authority distribution system, Landsdale, Pennsylvania. It shows good correspondence with observed field data. (Author's abstract)
W88-09982

FILTER BOTTOM CONSTRUCTION,
Roberts Filter Mfg. Co., Darby, PA.

For primary bibliographic entry see Field 5D.
W88-10071

OWNERSHIP AND EFFICIENCY IN THE WATER SUPPLY INDUSTRY: AN APPLICATION OF THE NONPARAMETRIC PROGRAMMING APPROACH TO EFFICIENCY MEASUREMENT,
Southern Illinois Univ. at Carbondale. Dept. of Economics.
P. Byrnes.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8622963. Ph.D Dissertation, 1986. 325 p, 9 fig, 46 tab, 123 ref, 5 append.

Descriptors: *Water supply, *Linear programming, *Systems analysis, *Productivity, *Utilities, Municipal water, Public policy.

Technical efficiency within the total productive efficiency of water utilities was measured and differences owing to ownership form were assessed. The methodology was applied to a sample of public and private water utilities using a nonparametric linear programming approach. The pooled sample input technical efficiency measures indicate that the utilities in the sample are operating at about 93% efficiency. Congestion and scale inefficiency appear to be the source of inefficiency with the relatively small efficiency losses due to deviation from purely technical efficiency. Decomposition of the pooled sample measures and analysis of the separate sample measures reveals that the pooled sample inferences hinge on the assumption that the public and private utilities face the same technology and operate in similar environments. Analysis of the inter-sample measures reveals a significant difference in the sample distribution of total, congestion, and scale efficiency between public and private utilities. The empirical assessment of the relationship between ownership form and efficiency evidently depends on the model specification and, particularly, on the regularity conditions which the water industry technology is assumed to satisfy. (Cremmins-AEPCO)
W88-10079

SEARCH FOR PURITY: A RETROSPECTIVE POLICY ANALYSIS OF THE DECISION TO CHLORINATE CINCINNATI'S PUBLIC WATER SUPPLY, 1890 - 1920,
Cincinnati Univ., OH. Div. of Graduate Studies and Research.
C. K. O'Toole.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8622259. Ph.D Dissertation, 1986. 148 p, 1 fig, 4 tab, 48 ref, append.

Descriptors: *Chlorination, *Water treatment, *Water supply, *Public waters, *Decision making, Public health, Technology, Social aspects, Political aspects, Policy making, Bacterial analysis, Water analysis, Disinfection, Water resource development, Drinking water.

The background and chronology of events leading to the regular and continuous chlorination of the public water supply in Cincinnati, Ohio are reviewed and the technological, social, and political aspects of this decision are analyzed. The state of the art in bacteriology, water analysis, and disinfection are discussed and the issue of standards in methods and in quality is investigated. A historical perspective to the current problem is provided and a set of tried approaches toward ensuring the safety of a drinking water supply is suggested. The types of social relationships and support systems which may aid contemporary water resource planners in their decision processes are recommended. (Cremmins-AEPCO)
W88-10087

5G. Water Quality Control

RCRA GROUND WATER MONITORING TECHNICAL ENFORCEMENT GUIDANCE DOCUMENT (TEGD).

For primary bibliographic entry see Field 4B.
W88-08976

STANDARDIZED SYSTEM FOR EVALUATING WASTE-DISPOSAL SITES,
For primary bibliographic entry see Field 5E.
W88-08981

PROCEEDINGS OF THE FIRST NATIONAL OUTDOOR ACTION CONFERENCE ON AQUIFER RESTORATION, GROUND WATER MONITORING AND GEOPHYSICAL METHODS.
Las Vegas, Nevada. May 18-21, 1987. Sponsored by The Association of Ground Water Scientists and Engineers. National Water Well Association, Dublin, OH. 1987. 657 p.

Descriptors: *Symposium, *Conferences, *Water pollution treatment, *Aquifers, *Groundwater management, *Groundwater pollution, Monitoring wells, Sampling devices, Remote sensing, Groundwater, Geophysics, Groundwater monitoring.

The First National Outdoor Action Conference on Aquifer Restoration, Groundwater Monitoring and Geophysical Methods was held in Las Vegas, NV in May 1987. The meetings were intended to be a definitive groundwater education program featuring outdoor demonstrations and workshops involving techniques and equipment used throughout the industry. The meetings were divided into 9 sessions covering the following topics: aquifer restoration (remediation of petroleum hydrocarbons and other contamination and case histories); groundwater monitoring (sampling and analysis monitoring well design), and monitoring well drilling); unsaturated zone monitoring and sampling; and geophysics (utilizing seismic and gravity techniques for groundwater investigations, remote sensing techniques for groundwater investigations, and utilizing magnetic, electromagnetic, and resistivity techniques for groundwater investigations). (See W88-08992 thru W88-09028) (Alexander-PTT)
W88-08991

INNOVATIVE BIOLOGICAL TREATMENT OF CONTAMINATED GROUNDWATER,
DETOX, Inc., Dayton, OH.
E. K. Nyer.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 3-17. 7 fig.

Descriptors: *Water pollution treatment, *Biological treatment, *Organic compounds, *Groundwater pollution, *Water treatment facilities, *Water treatment, *Aquifers, Groundwater management, Aerobic conditions, Anaerobic conditions, Ketones, Acetone, Phenol, Detox Bioreactors, Groundwater.

Biological treatment is a proven process for the destruction of organic chemicals. More than 99% of all known organic compounds can be treated by biological systems. The main advantages of biological treatment are that it is relatively inexpensive. The main disadvantage of biological treatment is that it has to run continuously, 24 hours per day, 7 days per week. The basics of a biological reaction are the same no matter where the reaction is taking place. Bacteria in the vessel consume the organics in the water, they use as a food source to provide energy and building blocks for new bacteria. In addition to the organics in the water, the reaction requires oxygen (for an aerobic reaction), and nutrients, primarily NH3 and PO4. The byproducts of the reaction are CO2, H2O, and new bacteria. The bacteria require the correct environment for maximum growth. The temperature must be maintained between 50 F and 105 F, with the best results found between 65 F and 90 F. The pH must be maintained between 6 and 9. This corresponds to most discharge requirements, and normally does not present a problem. High concentrations of toxic or inhibitory compounds must not be present. These compounds can be inorganic or organic in nature. Case histories are given for three examples of the Detox L-series design of above-ground bioreactor. These three plants treat organic carbons, phenol, methyl ethyl keton, and acetone and process from 22,000 - 350,000 gal/day. (See also W88-08991) (Alexander-PTT)
W88-08992

SMALL SCALE WATER TREATMENT SYSTEMS FOR REMEDIATING CONTAMINATED GROUND WATER,
Geraghty and Miller, Inc., Oak Ridge, TN.
P. D. Kuhlmeier.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 19-36. 4 fig, 5 tab, 13 ref.

Descriptors: *Water pollution treatment, *Biological treatment, *Groundwater pollution, *Groundwater management, *Water treatment, *Water treatment facilities, *Organic compounds, Primary wastewater treatment, Secondary wastewater treatment, Tertiary wastewater treatment, Wastewater, Groundwater, In situ treatment, Estimating, Cost analysis.

Development of comprehensive low to moderate flow on-site treatment systems for aquifer restoration has seen a dramatic surge in popularity within recent years. Although still representing less than 2 percent of operating water treatment plants, hazardous chemical removal from groundwater could exceed 10 percent of all operating systems by the mid 1990s. To date three out of every four remedial on-site groundwater treatment systems use physical/chemical processes only, primarily due to the perceived high operation and maintenance costs associated with biological treatment and the wide range of compounds that are amenable in some form to physical/chemical removal. This trend appears to be reversing itself however as in-situ biological methods are starting to be accepted by state regulatory agencies. Unit processes employed to pretreat contaminated groundwater for POTW discharge include, fine screens, pH adjustment, flow mixing, floculation, coagulation, precipitation, clarification, and primary filtration. Secondary biological unit processes include activated sludge, trickling filters, and rotating biodisks. Tertiary units that are frequently used include activated carbon filtration and high temperature air stripping. The focus of this paper is to present the various types of complex wastestreams that may be handled through on-site semi-portable treatment plants and the costs associated with these systems. Three field applications in situ treatment, biological treatment, secondary physical/chemical treatment are presented and treatment cost estimating is discussed. (See also W88-08991) (Author's abstract)
W88-08993

DRAWDOWN IMPACTS IN DENSE NON-AQUEOUS PHASE LIQUIDS,
Conestoga-Rovers and Associates, Waterloo (Ontario).
K. Schmidtke, E. McBean, and F. Rovers.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 39-51. 3 fig, 4 tab.

Descriptors: *Water pollution treatment, *Aquifer management, *Cleanup, *Hydraulic containment, *Non-aqueous phase liquids, *Chlorinated hydrocarbons, *Organic compounds, *Groundwater pollution, *Groundwater management, *Aquifers, Design criteria, Design standards, Monitoring wells, Hydraulic conductivity, Permeability coefficient, Fluid mechanics, Hydrodynamics, Hydrology, Groundwater, Drawdown, Cooper-Jacob method.

A recently-completed field program to collect data for the evaluation of design criteria for the hydraulic containment and removal of dense non-aqueous phase liquids (DNAPL) and aqueous phase liquids (APL) is described. The Cooper-Jacob method is utilized to estimate the aquifer transmissivity and storage coefficient. Estimates of hydraulic conductivity and permeability from drawdown data for DNAPL and APL are derived to indicate how the relationships based on fluids principles may be successfully employed for design of recovery systems. (See also W88-08991) (Author's abstract)
W88-08994

HYDROCARBON RECOVERY PUMP FOR LOW TRANSMISSIVITY AQUIFERS,
Geoscience Consultants Ltd., Albuquerque, NM.
C. A. J. Schleyer, and R. T. Hicks.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 53-65. 6 fig.

Descriptors: *Water pollution treatment, *Cleanup, *Aquifer management, *Pumps, *Fuel spills, *Groundwater pollution, Groundwater management, Monitoring wells, *Groundwater monitoring, Aquifers, Economic aspects, Design criteria, Design standards, Groundwater, Fuel.

A 20,000 gallon diesel fuel leak at an oil refinery created what appeared to be a typical product plume which could be removed by a 2-pump product recovery method. Test pumping of the recovery well, however, revealed a transmissivity of 126 gpd/ft. At a rate of 0.88 gpm the well was pumped dry, while the product remained in the unsaturated zone. A special pump was designed based on the characteristics of the aquifer and the product plume. The pump is an air-operated cylindrical device which fills from the top under the influence of gravity and empties only when full. The pump is set in the well beneath the product/water table interface at a specified level and removes any product floating on the water plus enough water to maintain a drawdown in the well. In a low yield well it will operate intermittently as required, without any unnecessary cycling. Low cost and easy constructability from readily available components were primary objectives of the pump design. The unit requires compressed air at about 50 psi and 12 to 24 volts AC/DC for operation, and has a capacity of about 1 gpm at 60 feet of head. The cost of materials and components for a pump of this type, including the control box, is less than $300; and the cost of manufacture will vary but is estimated at $200. This is considerably less expensive than commercially available models. (See also W88-08991) (Author's abstract)
W88-08995

GROUND WATER MONITORING AND MITIGATION EFFORTS AT AN INACTIVE TAILINGS POND IN NORTHWEST MONTANA,
For primary bibliographic entry see Field 5B.
W88-08996

AMMONIA AND NITRATE MIGRATION FROM THE VADOSE ZONE TO THE GROUND WATER SYSTEM: CONTAINMENT, RECOVERY, AND NATURAL RESTORATION,
In-Situ, Inc., Laramie, WY.
A. C. Bumb, C. R. McKee, S. C. Way, J. T. Drever, and J. C. Halepaska.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 95-123. 16 fig, 8 tab, 17 ref, append.

Descriptors: *Water pollution treatment, *Industrial wastes, *Ammonia, *Nitrates, *Aquifers, *Groundwater pollution, *Groundwater management, Groundwater monitoring, Monitoring wells, Organic compounds, Leachates, Drinking water, Case studies, Groundwater, Monitoring, Fertilizers, Model studies, Anisotropy, Groundwater movement.

The manufacturing, packaging, transportation, and storage of fertilizer in the past has resulted in losses to the groundwater. Frequently these losses leach into the groundwater system at a rate described by first-order kinetics. At a fertilizer plant site,

groundwater sampling was used to determine the rate constant. Using the rate constant, the total amount of ammonia and nitrate in the groundwater was calculated. The calculated amount was in good agreement with borehole sampling estimates, and an analytical model was then used to calculate the time required to pump out the ammonia- and nitrate-contaminated groundwater so that natural restoration due to groundwater flow could take over together with ground water adsorption (ammonia only) and dispersion in order to lower product values offsite to drinking water standards. The analytical solution incorporates the time-dependent source function and allows for dispersion including anisotropic effects. (See also W88-008991) (Author's abstract)
W88-08997

CONTROL OF GROUND WATER CONTAMINATION IN AN ALLUVIAL FAN AQUIFER BY A DUAL HYDRAULIC BARRIER,
Stauffer Chemical Co., Richmond, CA.
L. E. Hall.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 125-142. 11 fig, 1 tab, 4 ref.

Descriptors: *Interception wells, *Water pollution treatment, *Alluvial fans, *Cleanup, *Aquifer management, *Groundwater pollution, *Groundwater management, Groundwater monitoring, Monitoring wells, Aquifers, Anisotropy, Hydraulic conductivity, Permeability coefficient, Nevada, Groundwater movement, Groundwater recharge, Hydrodynamics, Hydrology, Water quality, Case studies, Groundwater, Caliche.

Groundwater remedial action programs in the alluvial fan aquifers of the Basin and Range are complicated by anisotropic conditions, variable groundwater gradients, and the local occurrence of caliche. At a site in southern Nevada, contaminated groundwater was found to be migrating through an alluvial aquifer occupying a buried channel system. A field investigation program determined that groundwater gradients on the site ranged from 0.2 to 5.7 feet/100, permeabilities ranged from 20 to 2,250 gpd/ft, saturated thickness ranged from 0 to 30 feet and caliche was locally present at thicknesses of up to 16 feet. Secondary permeability in the form of voids in the caliche allowed the rapid movement of groundwater under local steep gradients. A remedial action program was initiated using the intercept method of the basis of ease of construction and flexibility in well ocation, as well as gaining the hydraulic benefit of the recharge of groundwater while remaining within regulatory guidelines. The dual hydraulic barrier consists of a line of intercept wells with a recharge area located downgradient of the intercept wells. Operation of the remedial action program began in December 1983. Water quality downgradient of the system has improved dramatically. Within the more permeable areas, contaminant concentrations have declined by 3 to 4 orders of magnitude. In less permeable areas, contaminant levels have declined from 44 to 98% of pre-startup concentrations. Thus, it is seen that the dual hydraulic barrier concept can effectively control the flow of contaminated groundwater in anisotropic alluvial fan aquifers. (See also W88-08991) (Author's abstract)
W88-08998

REMEDIATION OF HYDROCARBON CONTAMINATION WITHIN TRENCH-FILL MATERIALS ASSOCIATED WITH A 48-INCH WATER MAIN,
WESTEC Services, Inc., San Diego, CA.
J. C. Herwig, and G. A. Splawn.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 143-155. 3 fig, 1 tab, 1 ref.

Descriptors: *Water pollution treatment, *Cleanup, *Water mains, *Fuel spills, *Hydrocarbons, *Groundwater pollution, *Groundwater management, Groundwater monitoring, Monitoring wells, Organic compounds, Case studies, Groundwater.

During construction of a water pumping station, approximately 2000 gallons of contaminated hydrocarbon product were encountered within a manhole vault associated with a 48-inch water supply main located in the center of a major thoroughfare. Borings and monitor wells completed in the vicinity indicated that the hydrocarbon contaminant was situated primarily in a 300- to 400-foot linear section of trench-fill materials associated with the water main. Small amounts had also seeped into the surrounding limestone beds. The presence of the hydrocarbon contaminant created a hazardous situation which prevented completion of a tie-in to the water main. An extraction/injection circulation cell was established in the vicinity of the tie-in area to remove the surficial hydrocarbon product and to flush water containing dissolved gasoline components from the trench by means of a series of small-diameter well points. Following completion of tie-in construction, remediation of the remainder of the trench system was conducted by gradually moving the extraction/injection circulation cell through the entire length of the contaminated portions of the trench. The groundwater treatment system utilized during this project included both a tank separation process and air stripping that reduced contaminant concentrations in the effluent water by 90 to 97 percent. All surficial hydrocarbon product was removed by this procedure and the dissolved gasoline constituents within the water occupying the trench were reduced significantly. (See also W88-08991) (Author's abstract)
W88-08999

GROUND WATER SAMPLING: ADDRESSING THE TURBULENT INCONSISTENCIES,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Solid Waste Management.
For primary bibliographic entry see Field 7A.
W88-09004

ROLE OF AMBIENT GROUND WATER MONITORING IN STANDARD SETTING AND GROUND WATER PROTECTION STRATEGY DEVELOPMENT IN MINNESOTA,
Minnesota Pollution Control Agency, St. Paul.
For primary bibliographic entry see Field 7A.
W88-09005

NUMERICAL EVALUATION OF MONITORING WELL DESIGN,
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 7A.
W88-09006

USE OF GROUND WATER TRACER DURING WELL INSTALLATION,
Woodward-Clyde Consultants, Chicago, IL.
For primary bibliographic entry see Field 7B.
W88-09007

COMMENTS ON EPA'S EFFLUENT LIMITATION GUIDELINES FOR THE NONFERROUS METALS MANUFACTURING INDUSTRIES.
JACA Corp., Fort Washington, PA.
For primary bibliographic entry see Field 5E.
W88-09029

SUPERFUND: CIVILIAN FEDERAL AGENCIES SLOW TO CLEAN UP HAZARDOUS WASTE.
General Accounting Office, Washington, DC. Resources, Community and Economic Development Div.
For primary bibliographic entry see Field 6E.
W88-09053

RISK ASSESSMENT UNDER THE REVISED NATIONAL CONTINGENCY PLAN OF SUPERFUND,
Kirkland and Ellis, Washington, DC.
For primary bibliographic entry see Field 5E.
W88-09057

CASE STUDIES OF HAZARDOUS WASTE PROBLEMS IN LOUISIANA,
Louisiana Dept. of Natural Resources, Baton Rouge.
For primary bibliographic entry see Field 5E.
W88-09058

SAFETY EVALUATION OF PESTICIDES IN GROUND WATER,
CIBA-GEIGY Corp., Greensboro, NC. Agricultural Div.
For primary bibliographic entry see Field 5A.
W88-09112

RISK ASSESSMENT APPROACHES FOR GROUND WATER CONTAMINATION BY PESTICIDES AND OTHER ORGANIC SUBSTANCES,
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
J. F. Stara, J. Patterson, and M. L. Dourson.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 445-461, 1 fig, 4 tab, 28 ref.

Descriptors: *Pesticides, *Water quality standards, *Water quality, *Water quality control, *Groundwater, *Risk assessment, *Safety, *Organic compounds, *Groundwater pollution, Evaluation, Toxicity, Risks, Environmental Protection Agency, Hazards, Human diseases, Mathematical equations.

The Environmental Criteria and Assessment Office in Cincinnati (ECAO-Cin) of the U.S. Environmental Protection Agency (EPA) has been preparing health risk assessment documentation and developing methods useful for assessment of health hazards for single chemical chronic exposure for several years. In addition, ECAO-Cin has been instrumental in developing new and improving existing methods for health risk assessments of toxicants and mixtures of toxic chemicals. These methodologies are used to derive 'acceptable intakes' for systemic toxicants or 'risk specific intakes' for carcinogens. Sufficient data are needed in order to develop a satisfactory program for assessment of the human health risks associated with groundwater contamination by pesticides and other organic and inorganic pollutants. These data should include the types and concentrations of pollutants present, the potential and extent of exposure of the population at risk, and the toxicity data base on the individual chemicals or their mixtures. (See also W88-09089) (Author's abstract)
W88-09113

INDUSTRY PERSPECTIVE ON PESTICIDE AND GROUND WATER LEGISLATION,
CIBA-GEIGY Corp., Greensboro, NC. Agricultural Div.
For primary bibliographic entry see Field 6E.
W88-09114

GROUND WATER REGULATIONS: IMPACT, PUBLIC ACCEPTANCE, AND ENFORCEMENT,
Wisconsin Dept. of Agriculture, Madison. Trade and Consumer Protection.
For primary bibliographic entry see Field 6E.
W88-09115

GROUND WATER CONTAMINATION BY TOXIC SUBSTANCES: A CALIFORNIA ASSESSMENT,
California State Water Resources Control Board, Scaramento. Pollutant Investigations Branch.
For primary bibliographic entry see Field 5A.
W88-09116

TWO GROUND WATER CONTAMINATION PROBLEMS: CASE STUDIES,
New York State Dept. of Health, Albany. Bureau

of Toxic Substance Assessment.
For primary bibliographic entry see Field 5B.
W88-09117

EMERGING ROLE OF PESTICIDE REGULATION IN FLORIDA DUE TO GROUND WATER CONTAMINATION,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 6E.
W88-09118

CONSIDERING PESTICIDE POTENTIAL FOR REACHING GROUND WATER IN THE REGISTRATION OF PESTICIDES,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W88-09119

QUALITY ASSURANCE FOR A MEASUREMENT PROGRAM,
National Bureau of Standards, Washington, DC.
For primary bibliographic entry see Field 7A.
W88-09126

PROCEEDINGS OF THE THIRD NATIONAL SYMPOSIUM ON AQUIFER RESTORATION AND GROUND-WATER MONITORING.
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 4B.
W88-09129

NECESSARY INVOLVEMENT AND RESPONSIBILITY OF SEPARATE ENTITIES IN PLANNING AND PERFORMANCE OF AQUIFER RESTORATION,
For primary bibliographic entry see Field 6E.
W88-09130

FIRST EPA SUPERFUND CUTOFF WALL: DESIGN AND SPECIFICATIONS,
Goldberg-Zoino and Associates, Inc., Newton Upper Falls, MA.
J. E. Ayres, D. C. Lager, and M. J. Barvenik.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 13-22, 7 fig, 1 tab.

Descriptors: *Cutoffs walls, *Backfill, *Walls, *Bentonite, *Earthworks, *Leachates, *Water pollution control, *Slurries, Design standards, Construction, Capping, Seismic properties, Barriers, New Hampshire, Construction methods, Quality control, Monitoring, Excavation, Hydraulic conductivity.

Cutoff walls, which are being considered as a remedial tool for containment of leachates at several of the U.S. EPA's priority uncontrolled hazardous waste sites, generally take on several forms. The design inputs and specifications described in this paper focus primarily on soil-bentonite backfilled walls, and are taken from an investigative study completed and submitted to the EPA by private consultants in July 1981. The wall was planned for the Gilson Road uncontrolled hazardous waste site, Nashua, New Hampshire. The construction involved containment and capping of 80,000 sq m (20 acres), including about 20,000 sq m (204,000 sq ft) of slurry wall ranging in depth from 10 to 33 m (30 to 110 ft). Design inputs included additional field investigations, including test borings at 60 m intervals plus continuous seismic profile along the wall alignment; laboratory testing including gradation tests of on-site soils and hydraulic conductivity tests; updated water quality information obtained during ongoing monitoring programs. Specifications are listed for the gradation and materials used for the backfill, hydraulic conductivity, required depth of trench, excavation methods, and required tools. The backfill design mix incorporated both silt-size material and bentonite to reduce the hydraulic conductivity of the mix. Fine sands were added to reduce the amount of costly bentonite needed and to allow easy mixing with the dry bentonite. The use of the fines also reduced the hydraulic conductivity of the mix to about .00005 cm/sec. Sieve testing indicated that the average percent of fines actually achieved was 33 percent. The slurry trench at the site was excavated to depths up to 22m. Geologic conditions required that the wall be constructed through all the soil deposits to the top of the less permeable bedrock. Quality-control testing included pH and hardness of water, additives introduced into the slurry, the bentonite itself, and the backfill mix just prior to placement. Short-term verification testing centered around sampling of the in-place wall. Long-term verifications evaluated the resistance of the wall to chemical degradation. (See also W88-09129) (Friedmann-PTT)
W88-09131

ENVIROWALL VERTICAL CUTOFF BARRIER,
S. V. Arlotta, G. W. Druback, and N. Cavalli.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 23-27. 6 fig.

Descriptors: *Water pollution treatment, *Water pollution control, *Cutoff walls, *Water pollution treatment, *Water pollution control, *Barriers, *Linings, *Slurries, *Backfills, *Construction, Permeability, Porous media, Polyethylene, New Jersey, Bentonite, Dewatering, Excavation, Trenches, Sand.

The Envirowall cutoff is a hybrid cutoff wall, constructed with high-density polyethylene (HDPE) and sand backfill, installed with the slurry trench construction method. Its concept and construction methodology were demonstrated during a full-scale construction test in New Brunswick, New Jersey in 1982, to demonstrate its feasibility under difficult conditions. A one hundred-mil HDPE sheet is used to form an envelope which lines the walls of an excavated trench. The bentonite slurry used during construction keeps the trench stable for placement of the HDPE sheet and sand backfill. The sand backfill serves as a ballast and provides an internal, porous medium for monitoring seepage. The Envirowall cutoff has several advantages when used as a vertical barrier. The HDPE envelope provides a stable, low-permeability (10 to the minus 12th power cm/sec) membrane and, when installed in the trench, provides improved resistance to permeation and low overall permeability for the cutoff system. The slurry trench construction method allows installation of the Envirowall cutoff in areas with difficult site conditions. The bentonite slurry used in the construction of the cutoff maintains the stability of the trench during the installation of the Envirowall cutoff HDPE envelope. In the case where the waste is very aggressive toward the bentonite filter cake and HDPE such that the integrity of the membrane is reduced considerably, the sand medium with withdrawal wells or well points simulates the control structure for dewatering. This is especially beneficial where existing soil conditions at the site are not conducive for establishing an efficient pumping system for withdrawal. (See also W88-09129) (Friedmann-PTT)
W88-09132

ISOLATION OF CONTAMINATED GROUND WATER BY SLURRY-INDUCED GROUND DISPLACEMENT,
T. P. Brunsing, and J. Cleary.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 28-36, 7 fig, 4 ref.

Descriptors: *Groundwater pollution, *Groundwater management, *Leaching, *Water pollution control, *Barriers, *Construction, *Groundwater barriers, Slurries, Injection wells, Soil, Bentonite, Florida, Block displacement.

Groundwater supplies throughout the United States are threatened by leaching and migration of contaminants. A technique referred to as 'block displacement' has been developed for complete isolation of large tracts of contaminated ground. The block diplacement process is composed of separate bottom barrier and perimeter barrier construction processes. The bottom barrier construction is accomplished by propagating horizontal separations from a series of injection wells. A soil-bentonite slurry is pumped into these wells at low pressure opening the separation and forming a barrier. In the process, the ground is displaced upward by an amount corresponding to the thickness of the final barrier placed. Block displacement enables construction of a thick underground flow barrier without excavation of the space occupied by the barrier. Avoiding such excavation can be a major economic advantage. This paper describes the construction of a block displacement at an EPA Superfund site in Whitehouse, Florida, including density and gel strength of slurry used, bottom separation, mini displacement test, and verification of barrier continuity. (See also W88-09129) (Friedmann-PTT)
W88-09133

REMEDIAL PROGRAMS FOR GROUNDWATER SUPPLIES CONTAMINATED BY GASOLINE,
W. T. Chaffee, and R. A. Weimar.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 39-46, 8 fig.

Descriptors: *Groundwater pollution, *Water pollution treatment, *Cleanup operations, *Monitoring wells, *Water pollution treatment, *Groundwater management, *Gasoline, Plumes, Monitoring, Construction, Pollutant identification, Aquifers, Leakage, Storage tanks, Wastewater treatment, Waste recovery.

This paper discusses programs for investigating and cleaning groundwater supplies contaminated by gasoline. The programs are based on case histories of two gasoline storage tank leaks in communities. The primary techniques for determining the extent and movement of gasoline are described, and include monitoring well installation, gasoline lens detection, and contaminant plume detection. Small-diameter wells, 1 1/2 to 2 in inside diameter, are generally constructed of PVC casing and screen with threaded couplings. In determining the actual gasoline lens thickness, measurements taken from small-diameter monitoring wells are not accurate; hence, the presence of gasoline in a monitoring well is used only to indicate the location of the gasoline lens and, therefore, to delineate the extent of lens movement. Several methods can be used to detect the plume, including measurement of groundwater dissolved oxygen, temperature, microbial levels and organic vapor. Laboratory analysis for various hydrocarbons provides the most accurate and generally the most expensive method of measuring and locating gasoline plumes in groundwater. Gasoline recovery consists of removal of as much free product as possible from the aquifer. Final cleanup plans called for rehabilitation of the contaminated aquifer. This entailed creation of a small, closed system within the aquifer, including construction of an inner, shallow recirculation cell to contain and remove the contaminated groundwater, an outer, deeper recirculation cell to provide additional containment, and a treatment process composed principally of an oil/water separator, an air-stripping tower with vapor phase recovery and two GAC vessels connected in series. (See also W88-09129) (Friedmann-PTT)
W88-09134

SUBSURFACE HYDROCARBON SPILL, IDENTIFICATION AND RECOVERY,
For primary bibliographic entry see Field 5A.
W88-09135

TREATMENT TECHNOLOGY FOR REMOVAL OF DISSOLVED GASOLINE COMPONENTS FROM GROUND WATER,
For primary bibliographic entry see Field 5D.
W88-09136

HYDROCARBON CONTAMINATION OF CARBONATE AQUIFERS: ASSESSMENT AND ABATEMENT,
For primary bibliographic entry see Field 7A.
W88-09137

EVALUATION OF GROUND-WATER CONTAMINATION ASSOCIATED WITH THE USE OF ORGANIC SOLVENTS AT ROMANSVILLE, PENNSYLVANIA,
For primary bibliographic entry see Field 7A.
W88-09138

TRICHLOROETHYLENE OCCURRENCE AND GROUND-WATER RESTORATION IN HIGHLY ANISOTROPIC BEDROCK: A CASE STUDY,
SMC Martin, Inc., Valley Forge, PA.
For primary bibliographic entry see Field 5B.
W88-09139

USE OF ANALYTICAL MODELS FOR EVALUATING CORRECTIVE ACTIONS AT HAZARDOUS WASTE SITES,
GeoTrans, Inc., Reston, VA.
For primary bibliographic entry see Field 7C.
W88-09140

TREATMENT ALTERNATIVES EVALUATION FOR AQUIFER RESTORATION,
J. R. Absalon, and M. R. Hockenbury.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 98-104, 1 fig, 3 tab, 3 ref.

Descriptors: *Water pollution treatment, *Groundwater pollution, *Organic compounds, *Wastewater treatment, *Cleanup operations, *Water quality control, *Wastewater treatment, Aquifer management, Design criteria, Air stripping, Adsorption, Activated carbon, Activated sludge, Remedies, Hydrology, Geology, Organic compounds, Chemical engineering.

The treatment of contaminated ground water has received favorable attention in recent years as a remedial action of choice for many situations. This paper presents the methodology for one such treatment. This methodology requires technical input from several disciplines, including geology, hydrology, chemistry, chemical engineering, water/wastewater treatment, construction and treatment plant operations. The treatment alternatives evaluation consists of five sequential phases: problem identification, identification of treatment alternatives, bench- or pilot-scale treatability studies, process design/detail design, and construction/operations. The results presented are based on actual field experience. Treatments are categorized as physical, chemical or physical/chemical, biological, and residuals/supporting processes. Unit processes, their capabilities and limitations are listed for each treatment category. Typical ranges of key process design criteria used to achieve desired organic compound removals from water are: for carbon adsorption, contact time between 30 and 45 minutes (empty bed volume) and a hydraulic loading fo 2 to 4 gpm/sq ft; for air stripping, 10 to 80 scf air/gal, downflow packed tower, > 50 percent flooding velocity; for activated sludge, sludge age 10 to 30 days, hydraulic retention >24 hours. (See also W88-09129) (Friedmann-PTT)
W88-09141

LIMITATIONS IN IMPLEMENTING AQUIFER RECLAMATION SCHEMES,
Schmidt (Kenneth D.), Fresno, CA.
K. D. Schmidt.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 105-110.

Descriptors: *Water pollution treatment, *Water pollution control, *Groundwater pollution, *Alluvial aquifers, *Arid lands, *Pumping, *Case studies, *Cleanup operations, Leachates, Evaluations, Assessments, Legal aspects, Southwest, Aeration zone, California, Land use, Pesticides, Uranium, Wastewater treatment, Monitoring, Regulation, Soil contamination, Vadose water, Hydrogeology.

This paper discusses some of the less widely cited generic aspects of problems encountered with reclamation of highly prolific alluvial aquifers in the southwestern United States. Case histories discussed are the dibromochloropropane area south of Fresno, California, an industrial plant in Central Valley, California, a pollution plume at a uranium mill in the Southwest, and leachate found beneath and downgradient of a landfill in the San Joaquin Valley. The author cites a number of problems that may be encountered in implementing aquifer reclamation schemes in the Southwest, including: (1) treatment and disposal of large amounts of polluted water, (2) legal constraints on ground-water pumpage, (3) land access problems for monitor and extraction wells, (4) surrounding hydrogeologic influences, such as pumping of large-capacity wells and recharge sources, (5) public and/or regulatory agency pressure to act quickly, before the hydrogeologic framework is sufficiently understood, (6) large volumes of polluted soil and geologic materials that cannot be feasibly removed, and (7) substantial amounts of pollutants in the vadose zone. (See also W88-09129) (Friedmann-PTT)
W88-09142

DESIGN, OPERATION AND RESULTS OF A PILOT PLANT FOR REMOVAL OF CONTAMINANTS FROM GROUND WATER,
Weston (Roy. F.) Inc., Concord, NH.
B. L. Lamarre, F. J. McGarry, and E. L. Stover.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 113-122, 9 fig, 5 tab.

Descriptors: *Water pollution treatment, *Groundwater pollution, *Wastewater treatment, *Aquifer management, *Chemical treatement, *Heavy metals, *Cleanup operations, Case studies, Iron, Precipitation, Air stripping, Pilot plants, Temperature, Liming, Chemical pollution, Hydrogen ion concentration, Lead, Chromium, Suspended solids, Manganese, Polymers, Arsenic, On-site tests.

Pilot-scale treatability studies were conducted to develop a data base for final design of a full-scale ground-water treatment system. The processes piloted on-site were chemical precipitation for removal of iron, manganese and heavy metals and high-temperature air stripping (HTAS) for removal of volatile organics. Removal of iron and manganese by addition of lime was shown to be the most appropriate chemical addition system with an optimum pH level of 10.0 High molecular weight anionic polymer was found to be an effective flocculant aid at dosages of 1 ppm. Bench-scale studies indicated that the stripping column became fouled very rapidly if the raw ground water was process through it without first removing the iron and manganese, which were at levels of 352 mg/L and 90 mg/L, respectively. Neutralization of the overflow from the clarifier was accomplished with both carbon dioxide and sulfuric acid. Results showed that iron removal was more than 99 percent under all conditions tested. Its concentration was reduced from an average level of 50.2 ppm to an average of 0.28 ppm for a 99.4 percent removal efficiency. Manganese removal was greater than 99.8 percent at pHs of 10 and 11 and at polymer doses of 0.5, 0.75 and 1.0 ppm. Arsenic removal was 95 percent, total chromium 86.7 percent and lead 66.7 percent. Total suspended solids removal in the clarifier showed a more distinct trend than iron and manganese removal. Iron and manganese removal efficiency was approximately the same for pHs of 10 and 11 and at polymer doses of 0.5, 0.75 and 1.0 ppm. Below pH 10 manganese removal efficiency decreased. Total suspended solids removal decreases with pH although not dramatically. (See also W88-09129) (Friedmann-PTT)
W88-09143

GROUND-WATER DECONTAMINATION AT THE ROCKY MOUNTAIN ARSENAL,
Rubel and Hager, Inc., Tucson, AZ.
D. G. Hager, C. E. Smith, C. G. Loven, and D. W. Thompson.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 123-134, 13 tab, 4 fig.

Descriptors: *Water pollution treatment, *Organic compounds *Barriers, *Aeration, *Incineratikon, *Groundwater pollution, *Cleanup operations, *Groundwater barriers, *Cutoff walls, *Slurries, *Wastewater treatment, Soil contamination, Chemical treatment, Arsenals, Weapons, Wells, Rocky Mountain Arsenal, Volatile chemicals, Gas stripping.

Rocky Mountain Arsenal facilities are currently being used to destroy obsolete weapons and military hardware. These activities have contaminated the soil and ground water in the area. The Program of Installation Restoration was initiated in 1974, to deal with this contamination. The contaminated ground water is being contained at its northern and northwestern boundaries by a combination of hydraulic and slurry-wall barriers. The contained water is extracted, purified by granular activated carbon treatment and reinjected into the ground. Ground water from the chemical production area was studied to determine treatment processes to remove both organic and inorganic contaminants. Studies have been conducted on the removal of volatile organic contaminants via dissolved gas stripping and packed column aeration. Incineration of off-gases from the gas stripping tests was also evaluated. The study conclusions were (1) dissolved gas stripping techniques employing either air or carbon dioxide removed 51 to 73 percent of volatile organics found in water from three wells in the chemical production area using 0.006 and 0.3 SCF per gallon, respectively; (2) incineration of the volatile chemicals in the gas stripping off-gases destroyed two-thirds of the contaminants using a temperature of 1,400 F and a residence time of 29 seconds; and (3) packed column aeration using 6.67 to 13.13 SCF of air per gallon of water removed 90 percent or more of the volatile chemicals with the exception of chloroform from the three wells under investigation. (See also W88-09129) (Friedmann-PTT)
W88-09144

ASSESSMENT OF GROUND-WATER CONTAMINATION AND REMEDIAL ACTION FOR A HAZARDOUS WASTE FACILITY IN THE GULF COAST,
Ecology and Environment, Inc., Kansas City, KS.
P. L. Fitzwater, C. L. Brassow, and C. W. Fetter.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 135-141, 3 fig, 1 tab, 2 ref.

Descriptors: *Water pollution treatment, *Hydrogeology, *Hazardous wastes, *Land disposal, *Groundwater pollution, *Cleanup operations, *Seepage, *Leachates, *Construction methods, Geohydrology, Brackish water, Texas, Linings.

This paper describes a hydrogeologic investigation and subsequent closure plan for a liquid and solid waste pit at a hazardous waste processing and disposal facility located in the Gulf Coastal plain south of Houston, Texas. Liquids from the earthen pit were suspected of seeping into the shallow ground water, which is locally brackish. Results of the hydrogeologic investigation and the closure plan are discussed. Geometry of the earthen pit and sampling of the sludge are also described. The closure plan included applying a vertical surcharge to the waste material so that any free leachate will be squeezed out and collected, resulting in the waste material being compressed. The construction process included skimming off and removing all free liquid from the surface of the pit, application of a permeable geotextile fabric over the surface of the pit to act as support for the initial sand pad, and installation of an upper drain around the perimeter of the perimeter of the ponds to collect leachate coming through the sand blanket as a result of consolidation. Sumps were installed at regular intervals in the drain where pumping out

could be carried out. (See also W88-09129) (Friedmann-PTT)
W88-09145

CONTAMINATED GROUND-WATER RECOVERY SYSTEM ANALYSIS, DESIGN AND CONSTRUCTION AT A WASTE MANAGEMENT FACILITY LOCATED IN A GULF COASTAL PLAIN,
E. R. Underwood, and J. C. Thornton.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 142-148, 5 fig, 1 tab, 11 ref.

Descriptors: *Water pollution treatment, *Wastewater recovery, *Dewatering, *Linings, *Groundwater pollution, *Cleanup operations, *Dewatering, *Waste management, Saline water, Pumps, French drains, Silt, Reclaimed water, Groundwater models, Simulation, Aquifers, Pump wells, Depression storage.

A shallow, saline, non-potable saturated zone consisting of silty sand was slightly contaminated under a waste management facility when a pond liner was inadvertently punctured by construction equipment during a pond cleaning operation. This paper outlines work to date and the use of construction dewatering techniques in renovation of the contaminated zone. The paper also deals with the development of an improved groundwater model, groundwater simulation and evaluation of various corrective actions. A submersible pump ground-water recovery system was designed, consisting of 29 pumping wells, for the purpose of establishing a cone of depression adequate to contain and eventually remove ground water from the contaminated zone to an evaporation pond. Predicted quantities of recovered water were estimated at between one and five million gallons per year based upon the range of estimated permeabilities of saturated zone materials defined during well installation. It was determined that the system would be greatly improved if continuous drawdown at the wells could be maintained. A French drain with eductor systems was installed to produce a more dramatic cone of depression at a faster rate due to a larger surface contact with the saturated zone than individual wells. (See also W88-09129) (Friedmann-PTT)
W88-09146

DETECTION, CORRECTION AND RESTORATION OF MINING SOLUTIONS IN A CONFINED AQUIFER AT AN IN SITU URANIUM MINE,
J. C. Yelderman, and D. L. Durler.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 151-1613, 5 fig, 3 tab, 11 ref.

Descriptors: *Water pollution treatment, *Groundwater pollution, *Cleanup operations, *Mine drainage, *Uranium, *Groundwater movement, *Path of pollutants, Case studies, Leachates, Vertical flow, Trace metals, Mining solutions, Aquifer management, Recovery wells, Leaching solutions, Ammonia, Sulfates, Texas, Wells, Lixiviant solutions, Monitoring, Excursions, Molybdenum, Metals.

Potential short-term degradation of ground water at an in situ uranium mine can result from the lateral or vertical migration of mining solutions (an excursion). This paper (1) documents, through a case history, a migration of mining solutions into an overlying aquifer, (2) outlines methods of monitoring and detection, and (3) shows the type of corrective action, including cleanup. The mining process involves the use of injection and recovery wells selectively screened in the ore horizon such that leaching solutions can effectively and efficiently solubilize uranium. Typically, an alkaline-rich oxidant solution (lixiviant) is injected into the zone of interest through injection wells. The lixiviant mobilizes uranium, molybdenum and other metals that are withdrawn by submersible pumps at recovery wells. The cleanup described in this paper occurred at the Moser Mine in south Texas. The excursion was detected at monitor well MS-301, and appeared to be caused by nearby highway I-178, which exhibited communication with the shallow aquifer under the mine. The use of indicator parameters at the Moser Mine worked well as high values of electrical conductance and sulfate often warned operators of excursions before ammonia and trace metals appeared to confirm the fluid as lixiviant. During correction and restoration, some parameters such as ammonia, molybdenum and uranium took longer to extract due to retardation. The ammonia was probably retarded by exchanging with Mg, Ca, K or Na cations on the clays. Results showed that simple restoration techniques such as groundwater sweep can be successful in restoring groundwater quality values to baseline conditions after uranium lixiviant conditions. At an in situ solution mine, where there are hundreds of wells that may be the cause of pollution, it is of utmost importance to find the source of pollution and take corrective measures before cleanup begins. Proper well completion can help prevent excursions in overlying aquifers. Large-diameter monitor wells allow for multiple use in the detection, delineation and extraction of excursions in confined aquifers. (See also W88-09129) (Friedmann-PTT)
W88-09147

LABORATORY STUDIES ON NATURAL RESTORATION OF GROUND WATER AFTER IN SITU LEACH URANIUM MINING,
N. E. Bell, W. J. Deutsch, and R. J. Serne.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 162-168, 5 fig, 4 tab, 3 ref.

Descriptors: *Water pollution treatment, *Uranium mining, *Water pollution control, *Groundwater pollution, *Leaching solutions, *Uranium, *Pore water, Oxidation, Hydrogen ion concentration, Oxidation-reduction potentials, Lixiviant solutions, Syulfates, Iron, Ions, Aquifer management, Oxidation, Injection, Waste recovery.

When uranium is mined using the in situ leach method, a leaching solution (lixiviant) is injected into an aquifer containing the ore zone and a uranium-rich solution (pregnant lixiviant) is recovered and processed at a local surface facility. This paper describes a series of laboratory experiments conducted by Pacific Northwest Laboratory to investigate the potential for natural restoration of ground water in aquifers affected by mining of uranium with in situ leach methods. Tests included comparison of lixiviant and ground water, laboratory batch tests to determine the response of solution pH and Eh to contact with sediment, laboratory column tests to determine chemical changes in the lixiviant produces by flow through reduced sediment, column tests in the presence of air, tests for reactions between pore water and sediment, and tests for uranium reduction. Results showed that (1) solution Eh is affected by oxygen in the atmosphere (even at 100 ppm O sub 2 in a controlled atmosphere chamber), (2) pore water reacted with sediment during storage, with increases in H+, Fe3+ and sulfate ion suggesting pyrite oxidation, (3) effluent solution uranium concentrations are controlled by solution/sediment interactions, and (4) exposure of sediments and pore water to air caused oxidation, which probably contributed to the high U values. (See also W88-09129) (Friedmann-PTT)
W88-09148

MASSACHUSETTS WATER-SUPPLY CONTAMINATION CORRECTION PROGRAM,
For primary bibliographic entry see Field 6E.
W88-09149

COMPREHENSIVE AQUIFER EVALUATION AND LAND-USE PLANNING FOR AQUIFER RESTORATION AND PROTECTION IN ACTON, MASSACHUSETTS,
For primary bibliographic entry see Field 6B.
W88-09150

WATER-QUALITY MONITORING AT HAZARDOUS WASTE DISPOSAL SITES: IS PUBLIC HEALTH PROTECTION POSSIBLE THROUGH MONITORING PROGRAMS,
Texas Tech Univ., Lubbock. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W88-09151

DESIGN OF COST-EFFECTIVE CHEMICAL MONITORING PROGRAMS FOR LAND DISPOSAL FACILITIES,
For primary bibliographic entry see Field 7A.
W88-09152

HYDROGEOLOGIC INVESTIGATIONS OF FAILURE MECHANISMS AND MIGRATION OF ORGANIC CHEMICALS AT WILSONVILLE, ILLINOIS,
For primary bibliographic entry see Field 5E.
W88-09177

RECOVERY OF COAL GASIFICATION WASTES: AN INNOVATIVE APPROACH,
Pennsylvania Power and Light Co., Allentown. Environmental Management Div.
J. F. Villaume, P. C. Lowe, and D. F. Unites.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 434-445, 14 fig, 3 tab, 42 ref.

Descriptors: *Water pollution treatment, *Cleanup operations, *Waste recovery, *Coal gasification, *Mine wastes, Stratigraphy, Silt, Pumping, Upwelling, Liquid wastes, Glacial sediments, Gravel, Pennsylvania, Coal tar.

This paper describes the recovery of waste from a pre-World War II city coal gasification plant at Stroudsberg, Pennsylvania. An estimated 35,000 gallons of liquid coal-tar waste were trapped at this site in a stratigraphic depression formed by coarse glacial gravels overlying a fine silty sand. Recovery of the slightly viscous material is being accomplished through an in-ground pumping operation, where ground water is removed to cause an upwelling of the static coal-tar surface. This and an earlier technique not employing upwelling have resulted in the recovery of more than 7,000 gallons of virtually water-free, high btu product over a nine-month period. (See also W88-09129) (Friedmann-PTT)
W88-09180

STUDY OF CONTAMINANT PLUME CONTROL IN FRACTURED-POROUS MEDIA,
C. F. Tsang, D. C. Mangold, C. Doughty, and I. Javandel.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 446-452, 4 tab, 13 ref. Interagency Agreement AD89F 2A 175 and U.S. Department of Energy Contract DE-AC03-76SF00098.

Descriptors: *Simulation, *Pump wells, *Barriers, *Groundwater movement, *Groundwater pollution, *Containment, *Mathematical models, *Plumes, Waste disposal, Porous media, Mathematical equations, Advection, Chemical reactions, CPT code.

This paper presents the results of simulation studies for a series of scenarios involving the use of barriers or pumping wells to contain or remove a contaminant plume. The investigation had two goals: to demonstrate the capability of mathematical modeling techniques to study contaminant plume control and extraction procedures, and to explore generically what is expected to happen for a series of contaminant plume control and extraction scenarios. The calculational results presented in this paper are based on the numerical code CPT. The code involves a number of partial differential equations that describe the three-dimensional flow of fluids in a complex porous medium with or without the presence of discrete fractures. The code CPT, which was developed at the Lawrence

Berkeley Laboratory, employs the Integrated-Finite-Difference numerical scheme and calculates coupled thermohydrologic flows with simple chemical advective transport and reactions. The formulation includes the effects of density and viscosity variations of the fluid, gravitation or buoyancy effects, aquifer heterogeneity and complex boundary conditions. (See also W88-09129) (Friedmann-PTT)
W88-09181

CONTAMINATED GROUND-WATER CONTAINMENT/TREATMENT SYSTEM AT THE NORTHWEST BOUNDARY, ROCKY MOUNTAIN ARSENAL, COLORADO.
Corps of Engineers, Omaha, NE.
D. J. Pendrell, and J. M. Zeltinger.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 453-461, 7 fig, 4 ref.

Descriptors: *Water pollution treamtent, *Water pollution control, *Barriers, *Activated carbon, *Wastewater treatment, *Groundwater pollution, *Hydraulic barriers, *Cutoffs, Slurries, Cleanup operations, Chemical pollution, Contamination, Unconfined aquifers, Alluvial aquifers, Construction, Containment, Nemagon, Dibromochloropropane, Adsorption.

The Rocky Mountain Arsenal (RMA) is an Army facility that was constructed just northeast of Denver in 1942. The plant was used for manufacturing mustard gas, incendiary bombs and other munitions during World War II. Liquid chemical wastes from all of these operations were discharged into unlined basins, resulting in contamination of a shallow, unconfined, alluvial aquifer. This paper describes the design and construction of a containment/treatment system for the northwest boundary of RMA. Groundwater containment will be achieved by constructing a combination hydraulic barrier/bentonite slurry cutoff wall across the portion of the aquifer where ground water contaminated with Nemagon (DBCP) had been detected in the past and is presently migrating off the arsenal. The treatment system will consist of a raw water sump, feed pumps, pre-treatment filters, three identical parallel granular activated carbon pulse bed absorbers, post-treatment filters and a treated water sump. Each adsorber will be designed to remove organic contaminants, specifically DBCP, using 12 by 40 mesh, virgin granular activated carbon. Hydraulic bed loading will not exceed 8 gpm/sq ft with a minimum empty bed contact time of 15 minutes for the carbon contactor. (See also W88-09129) (Friedmann-PTT)
W88-09182

OIL SPILL CHEMICAL DISPERSANTS: RESEARCH, EXPERIENCE, AND RECOMMENDATIONS.
American Society for Testing Materials, Philadelphia, PA.
A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. 465 p. Edited by Tom E. Allen.

Descriptors: *Oil spills, *Cleanup operations, *Dispersants, *Water pollution treatment, *Oil pollution, Research priorities, Symposium, Chemical treatment, Fate of pollutants, Standards, Water pollution effects, Oil, Management planning, Toxicity.

Dispersant research has been addressing the following problems: (1) When dispersants should be used; (2) What the results will be of dispersant application; and (3) Short-term and long-term costs to the environment. These points are addressed by papers in this volume under the following section headings: (1) laboratory toxicity and effectiveness testing; (2) field effectiveness; (3) fate and effects; and (4) contingency planning and guidelines. (See W88-09184 thru W88-09210) (Lantz-PTT)
W88-09183

MEASUREMENT AND PREDICTION OF THE EFFECTIVENESS OF OIL SPILL CHEMICAL DISPERSANTS.
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
For primary bibliographic entry see Field 7B.
W88-09187

STATUS OF THE WARREN SPRING LABORATORY'S ROLLING FLASK TEST.
Dasic International Ltd., Romsey (England).
F. N. Martinelli.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 55-68, 1 fig, 4 tab, 4 ref, 3 append.

Descriptors: *Dispersants, *Oil spills, *Water pollution treatment, Performance evaluation, Field tests, Oil pollution, Oil, Cleanup operations.

The use of dispersants in the United Kingdom, work undertaken to improve the laboratory test for the assessment of oil spill dispersant efficiency, and some of the supporting ongoing work in the field of dispersant evaluation is described. The revolving flask test used to measure the efficiency of oil spill dispersants, has been modified to meet the requirements of a simple test procedure to select dispersants for use at sea in accordance with the regulatory requirements of the U.K. Ministry of Agriculture, Fisheries and Food. Test results depended on operator technique and equipment. A program involving manufacturers, oil companies, and users was undertaken to improve the technique and precision of the test. Reproducibility between laboratories was on the order of + or - 10% mean. The test has been correlated with spraying trials at sea in which a carpet of oil was sprayed with a commercially available dispersant and the amount of oil dispersed into the sea by wave action was visually assessed. There was generally good agreement among observers for each test run but fairly poor reproducibility between repeat tests. This may be partly accounted for by slight differences in spray rates between repeat tests but mainly it was due to the time dependence of the observations. What appears initially to be a good dispersant will appear poorer in time as oil droplets resurface. Nevertheless, there were obvious differences noticed between the dispersants, and the ranking order of efficiency obtained by averaging the results matched the ranking order obtained in the laboratory. (See also W88-09183) (Lantz-PTT)
W88-09188

VIEW OF THE MACKAY AND LABOFINA LABORATORY TESTS FOR ASSESSING DISPERSANT EFFECTIVENESS WITH REGARD TO PERFORMANCE AT SEA.
British Petroleum Co. Ltd., Sunbury-on-Thames (England). BP Research Centre.
D. C. Byford, and P. J. Green.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 69-86, 5 fig, 9 tab, 4 ref, append.

Descriptors: *Dispersants, *Oil spills, Marine environment, Waves, Cleanup operations, Performance evaluation.

A comparison has been made of the Mackay and Labofina tests for evaluating oil spill dispersants, in terms of showing correlation with effectiveness at sea. Both tests have been found to provide repeatable data on the efficiency of dispersants. Good agreement was obtained between the two tests for the efficiency ratings of five commercially available dispersants as well as for the identification of optimum surfactant combinations. When differences occurred between the two methods in the selection of optimum formulations, the cause was found to be the onset of wave damping affecting the Mackay test results. The major advantages of each test were speed and simplicity in the case of the Labofina test and the simulations of wind shear and wave-mixing action on dispersant treated oil at sea for the Mackay test. While both methods showed significant disadvantages, both were considered useful in predicting dispersant performance at sea. (See also W88-091830) (Author's abstract)
W88-09189

REVIEW OF THE RELATIONSHIP BETWEEN THE CHARACTERISTICS OF SPILLED OIL AND DISPERSANT EFFECTIVENESS.
G. P. Canevari.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 87-93, 4 fig, 9 ref.

Descriptors: *Oil spills, *Cleanup operations, *Dispersants, Performance evaluation, Water pollution treatment, Oil pollution, Chemical treatment, Geometry, Viscosity, Oil slicks, Oil.

The effectiveness of a particular chemical dispersant in usually determined by various laboratory tests. Such laboratory performance cannot always be replicated in the field. The physical and chemical aspects of the actually spilled oil influence dispersant performance in a manner that usually cannot be extrapolated from the laboratory tests. Some of the important parameters discussed in this paper are the geometry, viscosity, and lens effect of the slick and the type of crude oil. Very thin slicks are sometimes not truly dispersed but are collected into a multiplicity of surface lenses by the penetration of the relatively large dispersant droplet. Heavily weathered and very viscous oil can resist contact with the more fluid dispersant and dispersant 'roll-off' can ensue. An oil slick wherein 90% of the oil can be located in 10% of the area could result in overtreating some areas and undertreating others. The composition of the crude oil and its emulsion-forming tendency influence dispersant effectiveness regardless of other physical properties such as viscosity. This influence is more extensively discussed because of the unique effect of the crude oil composition on dispersant effectiveness. (See also W88-09183) (Author's abstract)
W88-09190

DROP-WEIGHT INTERFACIAL TENSION METHOD FOR PREDICTING DISPERSANT PERFORMANCE.
SRI International, Menlo Park, CA.
R. T. Rewick, K. A. Sabo, and J. H. Smith.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 94-107, 5 fig, 4 tab, 10 ref. EPA Contract No. 68-03-2611.

Descriptors: *Interfacial tension, *Dispersants, *Oil spills, *Water pollution treatment, Cleanup operations, Performance evaluation, Oil pollution, Drop weight, Diffusion, Oil, Viscosity, Chemical treatment.

The drop-weight test is an improved interfacial tension method for predicting the relative effectiveness of oil spill dispersant products. The test is based on the relationship between the weight of a drop of oil detached from a capillary beneath a dispersant-in-seawater solution and the lowering of the interfacial tension between oil and water. A single drop-weight measurement, consisting of about eight data points, can be used to predict several interfacial phenomena: the maximum surfactant concentration (cmc), the reduction in interfacial tension, and the packing efficiency of surfactant molecules at the oil/water interface. The effects of temperature and salinity on the test results can also be studied. It is thought that the reduction in interfacial tension is the key indicator to rank dispersant performance. The modified drop-weight interfacial tension test can be used with oils of

different viscosities and densities. An appropriately sized capillary is required to control the time required for the oil drop to reach equilibrium with the surfactant solution. The performance of twelve water-based dispersant products with light Arabian crude oil was predicted using the modified testing procedures. Three different ranking orders were observed, depending on the interfacial parameter selected for comparison. For another series of oil spill products, the ranking observed by the drop-weight method, based on the lowering of the interfacial tension, was similar to that observed for the same products and oil using the EPA test. An oil penetration test using the drop-weight apparatus measures the relative time for dispersants to migrate to the oil/water interface. Test results demonstrate that some products that efficiently lower the oil/water interfacial tension migrate relatively slowly through the oil column and might not be effective. (See also W88-09183) (Lantz-PTT)
W88-09191

EFFECTIVENESS OF OIL SPILL DISPERSANTS AT LOW SALINITIES AND LOW WATER TEMPERATURES,
Swedish Environmental Research Inst., Karlskrona.
C. M. Lehtinen, and A. M. Vesala.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 108-121, 6 fig, 1 tab, 26 ref.

Descriptors: *Oil spills, *Dispersants, *Salinity, *Water temperature, *Water pollution treatment, Baltic Sea, Performance evaluation, Chemical treatment, Cleanup operations, Oil pollution, Oil.

The effect of ambient low salinity and low water temperature in the Baltic Sea on the efficacy of dispersants was investigated in the laboratory using a Mackay-Nadeau-Steelman apparatus. Three dispersants were tested on two oils (fresh and weathered crude) at different water temperatures (4, 12, and 15 C) and different salinities (3, 7, and 12 parts per thousand (ppt)). The results show a strong dependency on water temperature for all the dispersants tested, although one chemical was less sensitive than the others in this respect. The dispersants showed significant differences between their sensitivity to changes in salinity and in the relationships between effectiveness and dosage. The stability of the dispersion obtained seems to be influenced by both type of oil and water temperature, and some difference between the chemicals was observed. The parameters studied strongly affected the performance of the dispersants. It is therefore essential to make a careful choice of dispersants for use in low salinity environments such as the Baltic Sea. (See also W88-09183) (Author's abstract)
W88-09192

CHEMICAL OIL DISPERSION IN TRIALS AT SEA AND IN LABORATORY TESTS: THE KEY ROLE OF DILUTION PROCESSES,
Institut Francais du Petrole, Rueil-Malmaison.
C. Bocard, G. Castaing, and C. Gatellier.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 125-142, 10 fig, 5 tab, 9 ref.

Descriptors: *Oil spills, *Dispersants, *Toxicity, *Bioassays, *Water pollution treatment, *Marine environment, Hydrocarbons, Water pollution control, Mediterranean Sea, Fate of pollutants, Wind driven currents, Mixing, Oil pollution, Field tests, Oil.

To minimize the ecological impact of oil at sea, dispersants are used to spread the spill across a large amount of water and thus make hydrocarbon levels low enough to be sublethal. Such an objective demands two correlative conditions: (1) that an oil-in-water emulsion can be obtained by adding the dispersant and (2) that rapid dilution conditions are provided by a downward motion of oil droplets and wind-induced velocity shear between surface and subsurface. In September 1981, two 6 cu m slicks in the Mediterranean Sea were treated by two concentrated dispersants. More than 1500 samples were taken at different depths during several hours following treatment and were analyzed by a differential method to measure separately oil and dispersant. Direct measures were also recorded by a continuous flow of water through a nephelometer and a spectrofluorometer. Despite apparently complete emulsification of the slick, the most efficient dispersant did not preclude some of the oil from resurfacing 6 hr after treatment. The short-term fate of dispersed oil was therefore under the control of the sea conditions, which limit dilution processes. Because any laboratory test in closed vessel cannot duplicate dilution factors, a new approach was developed to measure simultaneously the rate of dispersion and the behavior of test marine animals submitted to variable concentrations of potentially toxic substances during the flow of dispersed oil through a continuous system. The procedure was conducted for 4 hr in the presence of shrimp that were then moved to clean water aquaria to observe the number of survivors. Three dispersants were tested with an initial oil content of 2 gm/l and a dispersant/oil ratio of 0.05. The procedure was able to identify that one of the chemicals would be a bad dispersant and could differentiate between the toxic effects of two good dispersants by their lethal effects for a common toxicity index. (See also W88-09183) (Lantz-PTT)
W88-09193

USE OF REMOTE SENSING IN THE DETERMINATION OF DISPERSANT EFFECTIVENESS,
Esso Resources Canada Ltd., Calgary (Alberta). Research Dept.
R. H. Goodman, and M. R. MacNeill.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 143-160, 10 fig, 16 ref.

Descriptors: *Remote sensing, *Dispersants, *Water pollution treatment, *Oil spills, Marine environment, Infrared imagery, Ultraviolet radiation, Performance evaluation, Oil pollution, Oil, Data acquisition.

An experimental program to test the effectiveness of dispersants in an open-ocean, cold-water environment was conducted off St. John's Newfoundland in the fall of 1981. The dispersion of Lago Media oil by Corexit 9527 was investigated by using surface and subsurface sampling techniques combined with remote sensing which employed infrared (IR), ultraviolet (UV), and visual sensors to define the surface slick and show the position of the sampling vessels within the slick. Infrared photography was used to estimate the area of the thick slick because IR 'coolness' (darker gray level) appears to be indicative of thicker oil. The total extent of the slick was determined from the reflectance in the UV region. Both photographic and line-scanning imagery was used in the UV, and line scanner in the IR. Measurements were taken from a height of 500 to 800 m every 20 min of both a control slick and a slick to which dispersant had been applied from the air. A comparison of the two slicks shows a difference in the dynamics and gives some indication of the nature of the dispersion process. Problems with sampling and determination of hydrocarbons in the water column prevented the comparison of remote sensing results with those from water column chemistry. As a result of these experiments, it is shown that remote sensing can be used to obtain quantitative data on the spreading characteristics of an oil slick, changes in interfacial tension that affect dispersion as well as spreading. This technique has the potential to measure the effectiveness of a dispersant without the need for an extensive water sampling program. (See also W88-09183) (Author's abstract)
W88-09194

EVALUATION PROGRAM FOR AERIALLY APPLIED DISPERSANTS,
Government of Canada, Ottawa (Ontario).
S. D. Gill.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 161-165, 15 ref.

Descriptors: *Dispersants, *Sprays, *Water pollution treatment, *Oil spills, *Aircraft, Performance evaluation, Cleanup operations, Velocity, Oil slicks, Oil pollution, Chemical treatment.

The Canadian Offshore Aerial Application Task Force (COAATF) was convened in 1979 to conduct laboratory and field studies on the practical effectiveness of the aerial application of oil spill dispersant concentrates under Canadian environmental conditions. Several studies undertaken by COAATF are briefly reviewed with regard to their contribution towards this objective. One such study was contracted out by COAATF to determine the physical constraints on dispersant delivery systems for large aircraft, dispersant droplet generation, and downward transportation of the dispersant droplets. The study provided mathematical rationale for the following recommendations to gain better control over the dispersant once it left the aircraft. Aircraft flying at slower speeds and lower altitudes will reduce the swath width. Narrower swaths and higher dosage rates may be achieved for all resultant droplet sizes when the aircraft is flying upwind than when flying across the wind. (While oil slicks will have a tendency to form wind streaks, this recommendation is more applicable to overland field trials where it is not always possible to approach the test site on any heading). Higher pump rates, and thus nozzle exit velocities, reduce the wind shear and promote the deposition of larger droplets (on the order of 500 micrometers), which in turn fall within a narrower swath than smaller droplets. (See also W88-09183) (Lantz-PTT)
W88-09195

TREATMENT OF OIL SPILL FIRE HAZARDS WITH CHEMICAL DISPERSANTS: A CASE HISTORY,
Sunshine Chemical Corp., West Hartford, CT.
S. Kaufmann.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 166-174, 9 fig.

Descriptors: *Gasoline, *Water pollution treatment, *Oil spills, *Chemical treatment, *Dispersants, Case studies, Fire hazards, Contingency planning, Oil pollution, Training.

Federal contingency plans include the use of chemical dispersants to ameliorate hazardous situations caused by spills of flammable or explosive petroleum products. The leakage of 7,750,000 L (2,000,000 gal) of gasoline from a storage facility in Boston threatened a densely populated neighborhood of six-family tenement houses and a large racetrack that stabled hundreds of Thoroughbred horses. This led to the use of a chemical dispersant to neutralize the fire hazard. Favorable results by fire departments in recent years, as a result of training, have established dispersants as the method of choice to handle non-burning spill incidents. Even though the teams that responded to several such emergencies held the protection of life and property as paramount, no toxicological environmental effects were noted during subsequent observations. (See also W88-09183) (Author's abstract)
W88-09196

TOXICITY OF OIL SPILL DISPERSANTS TO MARINE ORGANISMS: A CURRENT PERSPECTIVE,
Department of the Environment, Ottawa (Ontario).

For primary bibliographic entry see Field 5C.
W88-09197

EFFECTS OF DISPERSANTS ON INCORPORATION OF VOLATILE LIQUID HYDROCARBONS INTO THE WATER COLUMN,
Texas A and M Univ., College Station. Dept. of Oceanography.
T. J. McDonald, J. M. Brooks, and M. C. Kennicutt.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 203-223, 15 fig, 5 tab, 9 ref.

Descriptors: *Dispersants, *Hydrocarbons, *Water column, Oil slicks, Aromatic compounds, Wind velocity, Viscosity, Volatile organics, Oil pollution, Chemical properties.

A study was conducted to assess the effect of dispersants on the incorporation of volatile liquid hydrocarbons (C5-C14) into the water column from surface oil slicks. A laboratory tank was used to vary a number of parameters including oil type, dispersant type, time of dispersant application, wind speed, and temperature. Water samples removed from an underwater sampling port indicated that the light aromatics (e.g., benzene to xylene) were the dominant compounds introduced into the water from dispersed oil. At lower temperatures a decreased amount of volatile liquid hydrocarbons (VLH) was incorporated into the water column because of the lower solubility. Wind speed had little effect on the amount of VLH incorporated into the water column within the experimental design. The chemical and physical properties of the oil exerted important influences on the type and concentration of VLH detected in the water column. The more viscous the oil, the less the dissolution of VLH. Immediate application of dispersant introduced the greatest amount of VLH into the water column. If the oil was weathered for 24 hr only small amounts of VLH were incorporated into the water column. A comparison of dispersants Corexit 9527 and 7664 indicated that 9527 was most effective in accelerating VLH incorporation into the water column. (See also W88-09183) (Author's abstract)
W88-09198

RECOMMENDED METHODS FOR TESTING THE FATE AND EFFECTS OF DISPERSED OIL IN MARINE SEDIMENTS,
Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.
For primary bibliographic entry see Field 7B.
W88-09199

EFFECTS OF TEST SPILLS OF CHEMICALLY DISPERSED AND NONDISPERSED OIL ON THE ACTIVITY OF ASPARTATE AMINOTRANSFERASE AND GLUCOSE-6-PHOSPHATE DEHYDROGENASE IN TWO INTERTIDAL BIVALVES, MYA ARENARIA AND MYTILUS EDULIS,
Bowdoin Coll., Brunswick, ME. Marine Research Lab.
For primary bibliographic entry see Field 5C.
W88-09202

TOXICITY OF OIL AND CHEMICALLY DISPERSED OIL TO THE SEAGRASS THALASSIA TESTUDINUM,
Research Planning Inst., Inc., Columbia, SC.
For primary bibliographic entry see Field 5C.
W88-09203

EXPERIMENTAL USE OF DISPERSANTS FOR SPILL COUNTERMEASURES ON ARCTIC BEACHES,
Woodward-Clyde Oceaneering, Aberdeen (Scotland).
E. H. Owens, C. R. Foget, and W. Robson.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 324-337, 6 fig, 3 tab, 17 ref.

Descriptors: *Cleanup operations, *Dispersants, *Oil spills, *Arctic zone, *Water pollution treatment, Littoral zone, Intertidal areas, Oil pollution, Field tests, Shores.

Field experiments have been conducted on arctic beaches to assess the effectiveness of dispersants for the cleanup of stranded oil. The application of two commercially available chemical dispersants to aged and emulsified oil plots, in the intertidal zone on a semi-sheltered beach, resulted in a significant reduction of oil loadings immediately following the experiments as compared to loadings on adjacent intertidal control plots. The use of dispersants may, therefore, be of some value in mitigation of the potential adverse effects of oil immediately following stranding. In the semi-sheltered arctic environment in which the 1981 experiments were conducted (fetch up to 100 km; two-month open water season), natural reworking of the oiled intertidal control plots over a 40-day period was effective in removing approximately 85 to 95% of the original oil loading. Further experiments in 1982 replicated the 1981 study in a more sheltered location, with a fetch area of less than 2 km, and indicate that the use of dispersants was not effective in this very low energy environment. (See also W88-09183) (Author's abstract)
W88-09204

COMPARATIVE FATE OF CHEMICALLY DISPERSED AND UNTREATED OILS IN AN ARCTIC NEARSHORE ENVIRONMENT,
Battelle New England Marine Research Lab., Duxbury, MA.
For primary bibliographic entry see Field 5B.
W88-09205

ECOLOGICAL CONSIDERATIONS FOR THE USE OF DISPERSANTS IN OIL SPILL RESPONSE,
Atlantic Richfield Co., Los Angeles, CA.
For primary bibliographic entry see Field 5C.
W88-09206

DEVELOPMENT AND IMPLEMENTATION OF GUIDELINES FOR DISPERSANT USE: REGIONAL RESPONSE TEAMS,
National Ocean Service, Seattle, WA. Ocean Assessments Div.
R. Pavia, and R. W. Smith.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 378-389, 1 fig, 13 ref, append.

Descriptors: *Regional Response Teams, *Standards, *Planning, *Dispersants, *Water pollution treatment, *Oil spills, Contingency planning, Water pollution control, Cleanup operations, Documentation, Decision making, Management planning.

Since 1978, dispersant use guidelines have been developed and implemented for regional response teams (RRTs) in standard federal Regions IX and X, to enhance the RRT's ability to respond rapidly to requests to use dispersants. The guidelines define the data necessary to give approval. These data include physical, chemical, and biological parameters associated with spilled oil and dispersants. A decision to use dispersants is based on balancing the economic, social, and natural resource costs associated with oil spills. Damages expected from spills not treated with dispersants are compared to damages expected if the oil is treated. The objective of the guidelines is to help minimize the damage to natural resources. Specific criteria were developed by the RRTs as minimum standards for documentation of dispersant application, including the recording of dispersant type and application rates, visual observation of dispersant effectiveness, and monitoring environmental impacts. Summarized here is the progress of two RRTs in responding to requests for dispersant use, developing dispersant guidelines, and recommending minimum standards for documentation. Physical, chemical, and biological factors used in the decision process are also reviewed. (See also W88-09183) (Author's abstract)
W88-09207

MATHEMATICAL MODEL FOR PREDICTING THE ECOLOGICAL IMPACT OF TREATED AND UNTREATED OIL SPILLS,
Ross (S.L.) Environmenal Research Ltd., Ottawa (Ontario).
For primary bibliographic entry see Field 5C.
W88-09208

OIL SPILL DISPERSANTS: DOES SOUTH AFRICA HAVE AN ALTERNATIVE,
Sea Fisheries Research Inst., Cape Town (South Africa).
P. Chapman.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 414-427, 6 fig, 1 tab, 14 ref.

Descriptors: *Oil spills, *Environmental effects, *Self-purification, *Dispersants, *South Africa, Social aspects, Economic aspects, Marine organisms, Water quality control, Water pollution prevention, Contingency planning, Oceanography.

The role of geographic and socioeconomic factors on the effects of oil pollution in South Africa is discussed, including relevant geography and oceanography, pollution and marine organisms, government policy, dispersant testing, and contingency planning. When considering this question of response to oil spills as it applies to the long term ecology of the South African coast, an approach of 'no response' applies in the majority of cases, since the natural dispersive forces such as currents, wind direction, and surf action will do the job as efficiently, even if the time scale is somewhat longer. This rather simplistic approach obviously does not hold in the cases of Saldanha Bay or other areas of unique biological activity. If, however, the question is asked on socioeconomic rather than ecological grounds, then the answer may be rather different, since tourist area authorities do not like to see their beaches covered in oil. (See also W88-09138) (Lantz-PTT)
W88-09209

MULTIFACETED APPROACH TO APPLYING DISPERSANTS,
Aramco Services Co., Houston, TX. Engineering Dept.
O. L. Crain.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 428-435, 3 tab.

Descriptors: *Contingency planning, *Water pollution treatment, *Dispersants, *Cleanup operations, *Oil spills, *Arabian Gulf, Oil pollution, Chemical treatment, Booms, Spraying, Aircraft, Marine enviroment.

A comprehensive oil spill response plan has been developed partially to deal with accidental discharges of oil into the Arabian Gulf. The spill response capabilities of contractor companies in the area are fairly limited. The response plan relies on chemical agents and recovery as cleanup tools. The key to effective response is a rapid response and deployment of cleanup equipment. Initially, marine vessels equipped with portable dispersant spray booms patterned after the Warren Springs

equipment were used. To improve existing oil spill response, an extensive modernization of dispersant deployment equipment has been developed. The areas of modernization include: (1) upgrading the marine vessel equipment; (2) dedicating boats and vessels of opportunity for dispersant application; (3) using helicopters for spill response; (4) using large fixed-wing aircraft for spill response; and (5) establishing dispersant and refueling stodkpiles. (See also W88-09183) (Author's abstract)
W88-09210

MANAGEMENT PLAN FOR ESTABLISHMENT OF LITTORAL/WETLAND VEGETATION AT L-LAKE,
G. R. Wein.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 83-88, 2 fig, 2 tab.

Descriptors: *Water pollution control, *Lakes, *Wetlands, *Vegetation, *Littoral environment, *Revegetation, Maps, Nitrogen, phosphorus, Shoreline cover, Thermal pollution, Savannah River Plant.

In 1980, an increased demand for weapons-grade plutonium led to the decision to restart L-Reactor at the Savannah River Plant (SRP). During the precipitation of an Environmental Impact Statement for the renewed operation of L-Reactor, several alternatives for mitigation of the effects of thermal effluent discharge into Steel Creek were considered. These included the use of cooling towers, the discharge of effluent into Steel Creek without any treatment, and the construction of a large cooling lake. The last alternative was chosen because it was expected to be relatively inexpensive and more quickly constructed than cooling towers, while providing acceptable thermal mitigation. Because the 1000-acre (4-aq km) lake was development in the basin of Steel Creek, a tributary stream that discharges into the Savannah River, Section 316a of the Clean Water Act applies to the project. The cooling lake must, therefore, be managed to maintain a balanced biological community (BBC). In order to demonstrate good faith towards developed of a BBC within L-Lake shoreline vegetation must be established. Four problems or constraints might limit the success of establishment of littoral/wetland vegetation at L-Lake before the permit review period in 1987. These four constraints and their potential solutions were: (1) The shoreline along the lower half of the lake may not contain sufficient ground area for transplanting due to the extensive grading and removal of material for construction purposes; the shoreline should be graded to a 10:1 slope if possible. (2) A detailed contour map of the shoreline does not exist, but is necessary to ensure that the contractor can identify sites for planting; a contractor must survey the shoreline and produce a detailed contour map. (3) Areas that are to be planted must remain water-covered until plants are successfully established; DOE should be charged with the responsibility of maintaining a constant water level. (4) Nitrogen and phosphorus are critical inorganic nutrients in plant growth that may be found in low concentrations within the sandy substrate of L-Lake; the use of a slow release fertilizer during transplanting should avoid this problem. (See also W88-09211) (Lantz-PTT)
W88-09226

NATURAL VARIATION IN STREAM AND WETLAND ECOSYSTEMS AND THE EFFECTS OF DEFENSE WASTE PROCESSING FACILITY CONSTRUCTION,
For primary bibliographic entry see Field 5C.
W88-09227

GROUNDWATER TREATMENT TECHNOLOGY,
DETOX, Inc., Dayton, OH.
E. K. Nyer.
Van Nostrand Reinhold Co., New York. 1985. 188 p.

Descriptors: *Water treatment, *Groundwater pollution, *Water pollution treatment, *Groundwater quality, *Aquifers, Chemical treatment, Biological treatment, Cleanup operations, Organic compounds, Inorganic compounds, Adsorption, Wastewater treatment, In situ treatment, Costs, Safety, Heavy metals, Nitrates.

Groundwater detoxification methodology is in great demand as communities across the country discover aquifer contamination. Since groundwater cannot clean itself within a relatively short period of time, treatment must go beyond reducing or stopping waste seepage into the aquifer. Comparisons between wastewater and groundwater treatments point out the unique requirements of groundwater cleanup. This guide illustrates: (1) physical/chemical methods for organic contaminant removal (including design and application methods for pure compound removal, air stripping, and carbon adsorption); (2) biological methods for organic contaminant (traditional treatment systems and specific treatment systems for groundwater treatment); (3) treatment methods for inorganic contaminants (including methods for removing heavy metals, nitrates, and total dissolved solids); and (4) in-situ methods for organic contaminants including aquifer and unsaturated zone cleanup. For each method the author provides all the engineering parameters necessary to design operational, safe, and effective groundwater treatment systems, and analyzes specific costs for the various treatment technologies as well as the factors that affect those costs. (Lantz-PTT)
W88-09238

MANAGEMENT OF GROUND WATER QUALITY BENEATH IRRIGATED ARID LANDS,
Schmidt (Kenneth D.), Fresno, CA.
For primary bibliographic entry see Field 4B.
W88-09250

MANAGEMENT PRACTICES TO REDUCE NITRATE LEACHING WITH IRRIGATED CORN,
Agricultural Research Service, Lincoln, NE.
J. S. Schepers, and D. L. Martin.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 85-93, 4 fig, 1 tab, 14 ref.

Descriptors: *Water quality control, *Irrigation efficiency, *Nitrates, *Water quality management, *Fertilizers, *Corn, Leaching, Crop yield, Nutrients, Mineralization, Nitrogen, Soil water.

Irrigation scheduling and nitrogen fertilizer management practices are two effective ways to reduce the potential for nitrate leaching into groundwater. Even with careful management, some nitrate is likely to leach below the root zone of corn during the growing season, but the amount is usually small compared to that leached after the growing season. Amounts of fall and spring rainfall often exceed the soil water storage capacity, and thus residual soil nitrate may be leached below the rooting depth of the next crop. To manage soluble nitrate-nitrogen in the soil effectively, all forms of soil nitrogen must be considered as sources for crop uptake. Contributions of soluble nitrogen from organic matter mineralization are often ignored when fertilizer recommendations are made; however, the quantity of nitrogen derived from this source during the growing season may exceed the amount of nitrogen applied as fertilizer. Utilization of nitrate already in the groundwater is possible, but the overall effect on groundwater quality depends on the amount of water used and its nitrate-nitrogen concentration. Computer models are one way to evaluate various management practices effectively for their influence on groundwater quality. Long-term simulations indicate that, under present management practices for irrigated corn production, groundwater nitrate-N concentrations will eventually exceed existing water quality standards. (See also W88-09240) (Author's abstract)
W88-09251

COMPUTER CODES FOR MODELING IN CONJUNCTIVE GROUND WATER/SURFACE WATER MANAGEMENT PROGRAMS,
For primary bibliographic entry see Field 4B.
W88-09253

INTERGOVERNMENTAL MANAGEMENT STRATEGY FOR THE PROTECTION OF A CONJUNCTIVE USE RESOURCE,
Lane County Government, Eugene, OR.
R. W. Christensen, G. Rosenthal, and H. J. Youngquist.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 139-148, 11 fig, 14 ref.

Descriptors: *Interagency cooperation, *Management planning, *Resources management, *Groundwater management, *Water quality control, *Conjunctive use, Path of pollutants, Recharge, Wastewater disposal, Lakes, Aquifers, Florence, Oregon, Clear Lake, Model studies, Groundwater recharge, Sand aquifers, Water storage, Seasonal variations, Nitrates, Watershed management.

A comprehensive groundwater study using seismic techniques and digital modeling was undertaken to assess the impact of on-site sewage disposal systems on a large dunal aquifer-lake system. The study was initiated before any obvious problems had been observed in order to establish a groundwater management strategy to limit future degradation of the system. Two interconnected water districts conjunctively use water from the aquifer-lake system. The city of Florence, Oregon, pumps water directly from the aquifer through wells. The Heceta Water District uses water from Clear Lake, which is recharged from the aquifer. The pristine nature of the lake, which allows the district to deliver unfiltered (but chlorinated) water to its customers, would be in jeopardy if the groundwater that flows through it was allowed to degrade. It appears sufficient nutrient sources are in the watershed of the lake to cause degradation of its pristine character unless remedial action is taken. To protect the quality of the lake during examination of alternatives and facilities planning, state and local agencies used fixed term moratoriums on building permits and on-site sewage disposal permits, as well as state law and regulation directing regional rules and basin protection policies. The study model will be used to predict impacts of various watershed management practices. Coordination of state, county, city and other public agencies into a water quality management organization will provide an effective overall joint management plan. The plan will ensure optimal beneficial use of the aquifer-lake system for drinking water, recreation, housing and esthetics at acceptable monetary and social costs. (See also W88-09240) (Author's abstract)
W88-09256

TOWARD A COST-BENEFIT ASSESSMENT OF GROUND WATER QUALITY REGULATION,
Salt River Project, Phoenix, AZ.
C. G. Gibbs.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 219-225, 3 fig, 15 ref.

Descriptors: *Water quality control, *Groundwater, *Cost-benefit analysis, *Regulations, Water law.

Cost-benefit analysis is one of many techniques for assessing the effects of groundwater quality regulations. Effective cost-benefit assessments annually evaluate changes in discounts, total discharges, administrative charges, and aquifer recharge rates prior to accepting program benefits. The effects of increased monitoring and resultant data not only need to be considered as constraints that over time can be eliminated, but should be integrated into annual program revisions. Cost-benefit assessments are specific to individuals, sectors, and agencies. To assure desired outcomes, whether that be pro-

tecting existing users or projected users, both the regulators and those regulated should negotiate and modify the program. This is especially true when it is apparent that outcomes are overly dependent on certain assumptions. Some may believe that industry accepts cost-benefit analysis only because it works in industry's favor. However, values are increasingly assigned to public good and societal benefits when their true economic cost remains unknown. (See also W88-09240) (Cassar-PTT)
W88-09265

GROUND WATER QUALITY MANAGEMENT IN ARIZONA,
A. J. Gordon, J. B. Bale, and M. Bennett.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 226-232, 2 fig.

Descriptors: *Water quality control, *Groundwater, *Groundwater management, *Water law, *Arizona, Regulations, Standards, Water pollution control.

The Arizona Department of Health Services is empowered by statute to manage groundwater quality through the development and implementation of standards and regulations. Specifically, this task falls upon the Bureau of Water Quality Control. Regulations and standards for the protection of groundwater quality from both surface facilities and underground injection have just recently been developed. The groundwater quality standards are narrative; that is, there are no statewide numerical criteria. Standards will be set as permit conditions on a case-by-case basis for each specific facility. The water pollution control permit system will require compliance with established groundwater standards and consists of two articles. One article outlines the requirements for facilities affecting groundwater quality. The other article contains additional requirements for underground injection. These regulations have been developed in such as way as to allow for areawide water quality management plans for Active Management Area planning considerations to be included in the permit. An Active Management Area is a geographical area within the state that has been designated as requiring active management of groundwater quantity, primarily because of groundwater overdraft. Thus, some local control over groundwater quality protection is assured. These regulations have just recently been developed. As such, actual regulation has not yet been implemented. It is anticipated that new facilities will receive the highest priority, along with those existing facilities in which groundwater quality degradation has been documented. There are still several unresolved issues with respect to the groundwater program and regulations. It has not yet been determined how the National Pollution Discharge Elimination System program will be integrated with the groundwater program. (See also W88-09240) (Author's abstract)
W88-09266

DEVELOPMENT OF A PLAN TO PROTECT LOS ANGELES' SAN FERNANDO VALLEY GROUND WATER BASIN FROM INDUSTRIAL CONTAMINATION,
Los Angeles City Dept. of Water and Power, CA.
L. McReynolds.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 233-241, 1 fig, 2 tab.

Descriptors: *Water pollution control, *Water pollution prevention, *Industrial wastes, *Water pollution sources, San Fernando Valley, California, Chemical wastes, Organic compounds, Solvents, Chlorinated hydrocarbons, Management planning, Groundwater pollution.

Trichloroethylene (TCE) and perchloroethylene (PCE) were present at low concentrations in groundwater in scattered locations in the eastern San Fernando Valley, California. TCE occurred at concentrations above current drinking water recommendations in one-fourth of the wells tested. It was not possible to determine the specific origins of the contaminants or to accurately define plume patterns. Contamination was attributed to industrial and commercial developments. Most of the pollution occurred 20-40 years ago as a result of improper disposal practices before priority pollutant designations and hazardous waste regulations became established. Since these chemicals are not subject to significant biodegradation under the conditions met in this location, removal is the only apparent method for reducing contaminant loading. The eastern section of the San Fernando Valley is most vulnerable to contamination because of the large number of potential industrial and commercial sources and the high infiltration rates and extensive groundwater pumping. Since corrective measures are very expensive, efforts should be directed toward prevention of further input of chemicals into the groundwater system. The present regulatory structure is not yet developed to the extent that groundwater can be fully protected. Furthermore, many programs are designed with surface water in mind. Also needed are further interagency coordination and sufficient budget and manpower. (See also W88-09240) (Cassar-PTT)
W88-09267

CLATSOP PLAINS, OREGON: DUNAL AQUIFER EVALUATION AND GROUND WATER PROTECTION PLAN,
Sweet, Edwards and Associates, Inc., Kelso, WA.
H. R. Sweet.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 242-258, 7 fig, 11 tab, 43 ref.

Descriptors: *Sand aquifers, *Aquifer management, *Water pollution prevention, *Water quality control, *Oregon, *Groundwater management, *Waste disposal, *Water pollution sources, *Wastewater disposal, Septic tanks, Aquifers, Clatsop Plains, Model studies, Nutrients, Nitrates, Hydrologic models, Mass transport.

A 23-sq mi dunal aquifer on the northern Oregon coast was evaluated to determine historic, current and projected future impacts of waste disposal practices on the local groundwater flow system. Natural as well as man-made or induced nitrogen contaminant sources were inventoried, including vegetative dry matter accumulation, solid waste sites, an effluent irrigation system, and septic tanks and drain fields for on-site disposal. Hydrologic boundaries were used to delineate seven subbasins within the dunal aquifer, which were treated as continuous stirred tanks. Recharge to the subbasins was calculated using moisture balance techniques plus metered imported water. Calculated waste loading levels were coupled to the recharge volumes and resultant concentrations calibrated through a long-term monitoring program. Future nitrate-N levels were projected by accounting for the maximum year 2000 development densities. Within the Gearhart urban growth boundary, a more sophisticated finite difference hydrology model was developed. This model incorporated metered water usage, measured aquifer coefficients and historic, as well as current, recharge. Waste loading was directly measured. Dry matter and on-site waste disposal nitrogen loading were coupled to the hydrology finite difference model via a finite element solute mass transport model for calibration/verification by comparison to monitoring data gathered in the area. Projected waste loading levels under several development scenarios were evaluated to determine the long-term impacts to the local flow system. These modeling efforts were used to develop an areawide wastewater management/aquifer protection plan incorporating a set-aside area for long-term aquifer development; maximum on-site disposal system densities under conventional septic tank drain field, sand filter and low pressure distribution systems; sensitive areas that may require special treatment; waste disposal areas that require attention; and the basis for an amendment to the Oregon Administrative Rules pertaining specifically to the Clatsop Plains. (See also W88-09240) (Author's abstract)
W88-09268

USE OF WELL PACKERS TO CONTROL TCE AND PCE CONTAMINANTS,
Los Angeles City Dept. of Water and Power, CA.
G. Coufal, V. Smith, and R. Haw.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 343-350, 4 fig, 4 tab.

Descriptors: *Wells, *Well seepage, *Water quality control, *Groundwater, *Path of pollutants, *Chlorinated hydrocarbons, *Organic compounds, *Trichloroethylene, *Perchloroethylene, *Groundwater pollution, Solvents, Well packers.

Organic solvent contamination of production wells serving Los Angeles caused closure of several wells. In order to put these wells back into service, research was done on a typical well. The method involved installation of a well packer in an attempt to restrict the vertical movement of groundwater containing trichloroethylene (TCE) and perchloroethylene (PCE) to the zone above a clay lens where the greatest concentration of contaminants was believed to occur. Aquifer tests and water quality sampling indicated that water and contaminants from the upper zone were effectively prevented from reaching the lower zone and the pump suction. TCE concentrations were 100 ppb without the well packer and 7 ppb with the well packer; PCE concentrations were 4 ppb without the well packer and 0.5 ppb with the well packer. The average concentrations of contaminants during an eight-month test period using the well packer were 9 ppb TCE and 0.6 ppb PCE. Levels of organic contaminants increased to original high levels after the well packer was removed. (See also W88-09240) (Cassar-PTT)
W88-09278

PROCEEDINGS OF THE SIXTH NATIONAL SYMPOSIUM AND EXPOSITION ON AQUIFER RESTORATION AND GROUND WATER MONITORING.
National Water Well Association, Dublin, OH. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. 703 p.

Descriptors: *Symposium, *Conferences, *Monitoring, *Groundwater monitoring, *Groundwater management, *Groundwater pollution, *Monitoring wells, *Network design, *Sampling devices, Organic compounds, Hydrocarbons, Groundwater, Technology transfer, Aquifers, Analytical methods.

The Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring was held in Columbus, Ohio, May 19-22, 1986. The event was sponsored by the National Water Well Association along with the Robert S. Kerr Environmental Laboratory and the U.S. Environmental Protection Agency. Government officials, consultants, researchers, industry representatives and equipment manufacturers met to discuss ideas and exchange knowledge of the latest techniques and technology in aquifer restoration and groundwater monitoring. Subjects covered during the program included: monitoring well design, installation and maintenance: monitoring and sampling the vadose (unsaturated zone; groundwater monitoring network design; sampling and analysis of groundwater; bioreclamation and other in situ treatment techniques; and remediation of hydrocarbon and other organic contamination. In addition, the symposium featured and four point/counterpoint sessions: 'Should groundwater samples from monitoring wells be filtered before laboratory analysis; 'What is an adequate screen length for monitoring wells (Are dilution effects significant)'; 'Do casing materials really affect the integrity of groundwater samples obtained after the well has been purged'; 'How do drilling fluids and grouting materials

affect the integrity of groundwater samples from monitoring wells.' The proceedings are a compilation of papers presented at the symposium. (See also W88-09284 thru W88-09333) (Author's abstract)
W88-09283

COMPARISON OF VADOSE MONITORING PROCEDURES,
Alabama Univ., University.
For primary bibliographic entry see Field 2F.
W88-09288

EVALUATING FLUSHING AS A REMEDIAL ALTERNATIVE USING SOIL COLUMN TESTS,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
For primary bibliographic entry see Field 7B.
W88-09289

IMPACT OF THE CHANGED RCRA REGULATORY ENVIRONMENT UPON FACILITIES WITH GROUND WATER MONITORING,
Geraghty and Miller, Inc., Washington, PA.
For primary bibliographic entry see Field 6E.
W88-09296

UNDERGROUND STORAGE TANK MONITORING IN CALIFORNIA: AN EVALUATION OF RECENT LEGISLATION,
Kleinfelder (J.H.) and Associates, Walnut Creek, CA.
For primary bibliographic entry see Field 6E.
W88-09297

CHEMICAL INJECTION AND GROUND WATER RECOVERY TECHNIQUES FOR IN-SITU REMEDIATION OF A SUBSURFACE FORMALIN RELEASE - A CASE HISTORY,
Monsanto Polymer Products Co., Bridgeport, NJ. Delaware River Plant.
A. M. Cowie, and M. F. Weider.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 366-382. 7 fig, 5 ref.

Descriptors: *Water pollution treatment, *Hazardous wastes, *Waste recovery, *Formaldehyde, *Groundwater pollution, Water pollution sources, *Chemical treatment, Groundwater monitoring, Monitoring wells, Water pollution sources, Chemical analysis, Organic compounds, Aquifers, Groundwater, Pipelines, Massachusetts, Monitoring, Hydrogen peroxide.

Monsanto Company's Springfield, Massachusetts, plant was faced recently with the task of remediating a release of formaldehyde (an EPA-listed hazardous substance). This hazardous release occurred as a result of the failure of an underground pipeline. Preliminary analysis suggested no imminent threat to the environment because of physical subsurface conditions near the site. A study was undertaken to define various alternatives for treating the contaminated soil. A two-phase program consisting of chemical treatment of the formaldehyde in the soil with hydrogen peroxide and a system to recover any contaminated groundwater was designed and installed. Laboratory and field investigations preceded the actual installation of the treatment system. Two phases of hydrogen peroxide injection and soil sampling were conducted: after six months, the soil analyses showed that the formaldehyde had been completely neutralized. A groundwater beneath the site with all recovered groundwater re-routed back to the manufacturing process to avoid special handling as a hazardous waste. The remediation program was developed, proposed and modified in a cooperative working atmosphere with the Massachusetts Department of Environmental Quality Engineering (DEQE). Final completion of the groundwater portion of the remedial program is expected in mid-1987. (See also W88-09283) (Author's abstract)
W88-09314

APPLICATION OF MICROCOSM TECHNOLOGY TO STUDY THE BIODEGRADATION POTENTIAL OF A SUBSURFACE ALLUVIAL MATERIAL EXPOSED TO SELECTED PETROLEUM HYDROCARBONS,
Engineering Enterprises, Inc., Norman, OK.
For primary bibliographic entry see Field 5B.
W88-09315

GROUND WATER RESTORATION USING BIORECLAMATION IN FRACTURED PENNSYLVANIAN BEDROCK,
O.H. Materials Corp., Findlay, OH.
C. J. Coe.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 413-424. 10 fig, 2 tab, 14 ref.

Descriptors: *Water pollution treatment, *Pennsylvania, *Geologic fractures, *Methylethylketone, *Organic compounds, *Groundwater monitoring, *Biodegradation, *Groundwater pollution, Monitoring wells, Groundwater management, Chemical analysis, Water quality, Geohydrology, Hydrology, Aquifers, Path of pollutants, Water pollution sources, Groundwater recharge, Mapping, Activated sludges, Groundwater.

Groundwater restoration services were provided for a spill of approximately 5,000 gallons of methylethylketone (MEK) into fractured Pennsylvanian bedrock. A preliminary hydrogeological investigation revealed that both soil and groundwater were contaminated with MEK at levels up to 25,000 parts per million (ppm) in soil and 1,000 ppm in groundwater. Additionally, MEK was discovered in one domestic bedrock water well and a developed spring within 4 days after the spill. The mapping also verified that the fracture system controlled groundwater recharge and was hydraulically connected to the developed spring and the bedrock well. Based on the fracture trace analysis, two MEK seepage zones were defined at the intersection of cross cutting fractures. Hydrostratigraphic analysis revealed the main bedrock aquifer was a paleodistributary channel sandstone that cut the Upper Freeport No. 6 coal seam. Once the direction of MEK movement was defined, an in-situ biological treatment system was utilized to reduce MEK levels in both soil and groundwater. Two closed loop groundwater recovery systems were developed. The recovered groundwater was subsequently pumped to a series of storage pools and then processed using an activated sludge bioreactor. The reactor was seeded with microorganisms which utilize MEK as a carbon source. After treatment levels of less than 10 ppm were reached (i.e., 2 to 6 hours), the effluent was allowed to seep into the fracture system through a groundwater recharge pond. This served two functions: (1) the effluent flushed residual MEK from the soil into the groundwater it could ultimately be recovered and treated in the above-ground treatment system and (2) this nutrient- and microorganism-rich effluent enhanced in-situ biodegradation of MEK in both soil and groundwater, thereby reducing the overall treatment period. (See also W88-09283) (Author's abstract)
W88-09316

FIXED-FILM BIOREACTOR TO TREAT TRICHLOROETHYLENE-LADEN WATERS FROM INTERDICTION WELLS,
Oklahoma Univ., Norman. Environmental and Ground Water Inst.
For primary bibliographic entry see Field 5D.
W88-09317

FIELD DEMONSTRATION OF ENHANCED BIORECLAMATION,
FMC Corp., Princeton, NJ. Aquifer Remediation Systems.
R. A. Brown, and R. D. Norris.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 438-456. 4 fig, 7 tab.

Descriptors: *Water pollution treatment, *Bioreclamation, *Biodegradation, *Hydrocarbons, *Wastewater treatment, *Oil spills, *Cleanup operations, Groundwater monitoring, Groundwater pollution, Groundwater management, Geohydrology, Hydrology, Fate of pollutants, Aquifers, Monitoring wells, Physical properties, Field tests, Path of pollutants, Spatial distribution, Groundwater.

The remediation of petroleum spills has advanced in the past 5-10 years. Advances in hydrogeology, groundwater microbiology and geochemistry have yielded technology which effectively treats the spilled petroleum product in place: enhanced bioreclamation. By considering the properties of petroleum hydrocarbons and examining data from actual spills, one can understand their behavior in the subsurface and what is required for their effective treatment. Field data provides insight into how the site characteristics affect the distribution of petroleum hydrocarbons in the subsurface. In a field study of the enhanced bioreclamation of a gasoline spill, the extensive soil and groundwater sampling provided a detailed examination of gasoline contamination and how it responds to treatment. The topics covered are as follows: (1) an overview of the transport and phase distribution of petroleum hydrocarbons in the subsurface; and (2) an analysis of the treatment of subsurface petroleum contamination with enhanced bioreclamation; and (3) transport and phase distribution. (See also W88-09283) (Alexander-PTT)
W88-09318

GRAVITY FLOW HORIZONTAL DRAINS UTILIZED FOR IN-PLACE REMEDIATION,
Blasland and Bouck Engineering, Syracuse, NY.
G. W. Lee, E. R. Lynch, S. J. Rossello, and N. E. Gensky.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 457-464. 4 fig.

Descriptors: *Drains, *Landfills, *Drainage engineering, *Groundwater monitoring, *Groundwater pollution, *Monitoring wells, *Geohydrology, Hydrology, Aquifer testing, Design criteria, Design standards, Aquifers, Groundwater movement, Leachates, Groundwater, Test wells, Water table, Hazardous wastes, New York.

As a component of a hazardous waste landfill remediation program, a hydrogeologic investigation was completed in January-February 1984 to provide the technical data required to evaluate and design a groundwater control system. The in-place remediation concept was acceptable as long as the groundwater table could be reduced below the refuse contents of the landfill and a ten-foot separation between the newly established water table and the refuse could be maintained. The landfill site, located in Washington County, New York, is situated on a steep hill and is underlain by fine sands grading to silt above a lacustrine clay that is considered the lower boundary of the water table aquifer. Groundwater flow in this unconfined aquifer is topographically controlled and flows southeast following the general direction of the spring discharge paths. Based on boring and water level data, portions of the landfill refuse are situated below the existing water table level. This condition had to be corrected if the landfill was to be remediated 'in-place.' To determine the most efficient and economical groundwater control system that would achieve a minimum ten-foot separation between the refuse and the groundwater table, an aquifer test was run and the data was utilized in various well and lateral drain formulas. (See also W88-09283) (Author's abstract)
W88-09319

MONITORING AND RECOVERY OF FREE HYDROCARBONS,
Engineering Science, Cleveland, OH.
C. F. Raddell, and D. Palombo.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and

Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 466-481. 7 fig, 1 tab, 2 ref.

Descriptors: *Water pollution treatment, *Cleanup operations, *Waste recovery, *Oil spills, *Storage tanks, *Hydrocarbons, *Sediments, *Groundwater monitoring, *Groundwater pollution, *Monitoring wells, Groundwater management, Design criteria, Design standards, Aquifers, Groundwater, Geohydrology, Path of pollutants, Pumps.

A preliminary hydrogeologic assessment of an inactive petroleum bulk storage terminal resulted in the discovery of significant free product(s) atop a shallow water table. The site lies in a midwestern humid state where recharge occurs from direct precipitation. Most product was 'trapped' beneath the aboveground storage tank area where underlying fine grained sediments appeared to be saturated with product from the capillary fringe to below the stable water table. Investigations involving shallow test pits and additional wells resulted in a series of recommendations for recovery of the free product. The tank area and other areas of free product accumulation were controlled with different schemes of recovery. In the tank area, a series of trenches filled with gravel were effectively utilized with small air operated diaphragm pumps to quickly remove 30,000 gallons of product within a period of 10 weeks. This particular area was monitored with wells on a frequent basis in order to optimize the rate of recovery. The area was estimated to initially contain approximately 100,000 gallons entrained in the sediments. In other portions of the terminal, product of lesser volume was flowing uncontrolled toward a major river. This area required the installation of wells to recover product operated by air-diaphragm pumps in conjunction with a water depression pump. A 4-inch diameter well was used to depress the water table with a submersible pump while operating an air-diaphragm pump to skim off product accumulating in the well. The air pump is operated by a programmable controller on a timed basis. This well set-up had to be monitored frequently to identify the operational details. The recovery systems proved relatively inexpensive and are continuing to remove product. Suggestions for monitoring well construction and data interpretation are given. (See also W88-01283) (Author's abstract)
W88-09320

WATER SUPPLY CONTAMINATION CLEAN-UP IN MASSACHUSETTS,
Massachusetts Dept. of Environmental Quality Engineering, Boston.
D. R. Bowley.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 482-492. 8 fig, 2 ref.

Descriptors: *Massachusetts, *Cleanup operations, *Water treatment, *Water pollution treatment, *Drinking water, *Groundwater pollution, Water quality, Monitoring wells, Organic compounds, Legal aspects, Water supply systems, Water pollution sources, Case studies, Glacial aquifers, Well fields, Chlorinated hydrocarbons, Wastewater treatment, Legislation, Oil spills.

One-third of the people of Massachusetts depend on groundwater sources. Most of these wells are in glaciated surficial materials, and within 100 feet of the surface. Municipal groundwater sources tend to be in high yield sand and gravel aquifers near the surface. These supplies have proved vulnerable to contamination by a variety of organic chemicals. The Legislature responded by passing an innovative omnibus water act in 1982. The programs established by that Act have been reported previously. One of those programs is discussed and the past four years' of work toward water supply cleanup and protection engendered by it is described. Case histories at four locations are reviewed (a leaking gasoline tank; trichloroethylene, benzene, and other organic compound contamination; chlorinated hydrocarbon contamination; and trichloroethylene and dioxane and other organic solvents in a well field). Problems unique to individual sites and common to several are presented. Standard investigative techniques and some innovative approaches are discussed. Treatment proposals and methods chosen are examined. A study to prevent further aquifer contamination by pesticides and to indicate problem areas where agricultural chemicals may yet impact water supplies is discussed. Observations on the program to date are shared with the Symposium. (See also W88-09283) (Alexander-PTT)
W88-09321

EFFECTIVENESS OF AIR STRIPPING VERSUS ACTIVATED CARBON FOR REMOVAL OF DBCP, EDB, AND TCP AT ULTRA-LOW CONCENTRATIONS,
GMP Associates, Inc., Honolulu, HI.
For primary bibliographic entry see Field 5F.
W88-09323

ASSESSMENT AND REMEDIATION OF VOLATILE ORGANIC CONTAMINATION IN A SHALLOW ALLUVIAL AQUIFER,
Woodward-Clyde Consultants, Rockville, MD.
K. S. Makeig, and G. R. Chirlin.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 536-558. 8 fig, 4 tab, 11 ref, append.

Descriptors: *Waste disposal, *Organic compounds, *Groundwater pollution, *Aquifers, *Plumes, *Water pollution treatment, Virginia, Waste recovery, Ecological effects, Chemical analysis, Monitoring wells, Path of pollutants, Design criteria, Network design, Soil contamination, Land use, Cost analysis, Soil gases, Feasibility studies.

Over the course of 35 years, surface disposal of waste organic solvents and off-spec parts contaminated soils and groundwater at a small upland Virginia manufacturing plant. In anticipation of a property transfer, an environmental assessment of the site was conducted. Although initial work was restricted to the 'main' disposal area, the study evolved iteratively, with early soil and water analyses prompting additional questions about past land use practices. Continuing discussions with plant personnel led to increased understanding of the site and more informed placement of subsequent sampling points. Two, and possible three, source areas were identified, and associated contaminant plumes were detected in the groundwater. Contamination was not widespread, but concentrations of some volatile organic compounds exceeded 500,000 microgram/liter in one well. Criteria used to select the most suitable remediation technology included the type of contamination, constructability of the system, availability of the technology, length of time required to accomplish the cleanup objectives, space limitations, and cost. It was determined that groundwater extraction with air stripping would reduce the volatile concentrations as much as 90% with a single pass and 99% with two passes. The treated groundwater would be discharged to the nearby river under a permit. Contamination in the soil, although present, was not identified as a continuing source of contamination to the groundwater and would not need remediation under normal site conditions,. However, frequent flooding of the site could encourage greater releases to the groundwater from the soil due to the increase in infiltration rate. Soil gas extraction was recommended to minimize the possibility of contaminant loading from this source. (See also W88-09283) (Alexander-PTT)
W88-09324

REMEDIATION OF SUBSURFACE CONTAMINATION FROM VOLATILE ORGANIC COMPOUNDS USING SOIL GAS EXTRACTION TECHNIQUES,
Woodward-Clyde Consultants, Solon, OH.
R. E. Zimmermann, and V. M. Brizgys.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 580-591. 6 fig.

Descriptors: *Organic compounds, *Soil contamination, *Butadienes, *Waste recovery, *Soil gases, *Water pollution sources, *Groundwater pollution, *Path of pollutants, Groundwater monitoring, Monitoring wells, Groundwater management, Design criteria, Detection limits, Chemical analysis, Groundwater, Ohio, Leaks, Pipe lines.

In December 1983, leaking underground pipes from a northeast Ohio manufacturing facility were identified as the source of vapors detected in the basements of nearby residences. These underground lines transported 1,3-butadiene from several tanks to a flare stack. Woodward-Clyde Consultants was contracted to assess the lateral and vertical extent of contaminant migration and develop an emergency remediation program that would control the migration of the contaminants and effectively remove the contaminants from the subsurface. After identifying that the butadiene appeared to be concentrated just above and in the first few feet of the water table, a remedial plan was designed and implemented, which took advantage of the volatile nature of 1,3-butadiene. The recommended plan to draw the contaminants out of the subsurface consisted of the installation of several series of strategically placed soil gas extraction wells connected by above-ground manifold pipes with jet eductors, coupled with the installation of a similar extraction system installed in a gravel-filled trench. Shortly after the installation of these extraction systems, butadiene levels in nearby residences decreased below detectable limits. The soil gas extraction systems significantly controlled the off-site migration of butadiene, reduced its concentration in the subsurface, and decreased the concentration in the groundwater to below detectable limits. To monitor continued progress of the system at various locations beneath the plant, 17 soil gas monitoring wells were installed in existing boreholes. With the exception of four of the gas monitoring wells, which show fluctuating butadiene concentrations, continued monitoring of these wells has indicated a decrease in organic vapors beneath the plant site with time as a result of the soil gas extraction systems. (See also W88-09283) (Author's abstract)
W88-09326

LARGE-SCALE HIGH-EFFICIENCY AIR STRIPPER AND RECOVERY WELL NETWORK FOR REMOVING VOLATILE ORGANIC CHLOROCARBONS FROM GROUND WATER,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
L. F. Boone, R. Lorenz, C. F. Muska, J. L. Steele, and L. P. Fernandez.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 608-622. 3 fig, 1 tab, 3 ref.
DOE Contract DE-AC09-765R00001.

Descriptors: *Water pollution treatment, *Wastewater treatments, *Metal-finishing wastes, *Groundwater monitoring, *Waste recovery, *Air stripping, *Organic compounds, Design criteria, Design standards, Industrial wastewater, Chlorinated hydrocarbons, Heavy metals, Path of pollutants, Water pollution sources, Performance evaluation, Detection limits, Model studies, Analytical methods, Aquifers, Hydrology, Groundwater, Savannah River Plants, South Carolina, Pilot plants.

Since 1958 chemical wastes generated at the Savannah River Plant by an aluminum forming/metal finishing process used to manufacture nuclear fuel and target assemblies were discharged to a settling basin. This process waste stream contained acids, alkalis, metals, and chlorinated degreasing solvents. In 1981, these solvents, specifically trichloroethylene and tetrachloroethylene, were discovered in monitor wells near the settling basin. A monitor well network was installed to define the vertical and horizontal extent of the plume. The current inventory of total chlorocarbons in the saturated zone is approximately 360,000 pounds

within the 100 ppb contour interval. During 1983, air stripping technology was evaluated to remove these solvents from the groundwater. A 20-gpm groundwater pilot air stripper with one recovery well was tested. Performance data from this unit was then used to design a 50-gpm production prototype air stripper. This unit demonstrated that degreaser solvent concentrations in groundwater could be reduced from 120,000 ppb to less than the detection limit of 1 ppb. Data from these two units were then used to design an air stripper column that would process contaminated groundwater at a rate of 400 gallons per minute. Water is fed to this column from a network of 11 recovery wells. These wells were located in the zone of contamination as defined by analytical and numerical modeling techniques. This system has been operational since April 1985. to date, over 65,000 pounds of chlorinated degreaser solvents have been removed from an underlying aquifer. The effects of this program on the hydraulic gradient and contamination movement are currently being evaluated. The purpose of this paper is to describe the groundwater remediation program at the Savannah River Plant. (See also W88-09283) (Author's abstract)
W88-09328

CASE HISTORY - TREATMENT OF CONTAMINANT GROUND WATER USING ELEVATED TEMPERATURE AIR STRIPPING,
Rexnord, Inc., Milwaukee, WI. Corporate Research and Development Group.
J. L. Pope, and R. A. Osantowski.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 623-635. 4 fig, 9 tab.

Descriptors: *Wastewater treatment, *Water pollution treatment, *Activated carbon, *Air stripping, *Groundwater pollution, *Groundwater management, *Groundwater monitoring, *Organic compounds, *Chlorinated hydrocarbons, *Design criteria, *Design standards, *Monitoring wells, Chemical treatment, Performance evaluation, Groundwater, Case studies, Envirex Advanced Water Treatment System, Feasibility studies, Pilot plants, Temperature.

A remedial action program was initiated at an industrial site having groundwater contaminated with 1,1,1-trichloroethane (890 mg/L), carbon tetrachloride (75 mg/L), methylene chloride (11 mg/L) and other volatile organic compounds (VOC's). The objectives of the project were: (1) to perform bench tests to determine the feasibility of air stripping as a treatment alternative; (2) to perform a pilot study using the Envirex Advanced Water Treatment System to obtain design data for scale-up to a permanent full-scale system; and (3) to design and implement a full-scale treatment system which treats the groundwater to a total VOC concentration of less than 5 mg/L for discharge to the sanitary sewer system. Based on the bench scale test results, air stripping (with chemical pretreatment) was found to be technically feasible and the following treatment train was proposed for the pilot study: chemical coagulation with alum and anionic polymer, clarification, dual-media filtration and air stripping. Data were also gathered on granular activated carbon adsorption. During the pilot study, significant increases in acetone concentration were observed in the raw groundwater. This contaminant was not effectively removed with the treatment train used during the study. It was decided after additional laboratory tests and a literature review were performed that air stripping at 180 deg F would be effective in removing the acetone and the other VOC's present. Effluent analysis revealed that this process achieved up to 99% contaminant removal and the full-scale system was designed on this basis. (See also W88-09283) (Author's abstract)
W88-09329

INTERCEPTOR TRENCHES FOR POSITIVE GROUND WATER CONTROL,
Union Carbide Corp., Port Lavaca, TX. Polyofins Div.
S. G. Gilbert, and J. J. Gress.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 638-650. 3 fig, 3 ref.

Descriptors: *Water pollution treatment, *Barriers, *Interceptor trenches, *Groundwater pollution, *Groundwater monitoring, Groundwater management, Economic aspects, Design criteria, Design standards, Network design, Performance evaluation, Path of pollutants, Aquifers, Groundwater, Texas, Construction methods, Construction, Pipelines.

A new and efficient method for the construction of interceptor trenches has been developed and successfully installed by Industrial Builders, Inc. for several applications at a Union Carbide petrochemical facility on the Texas coastal plain. Rapid and cost-effective installation is made possible by innovations in sump and trench construction and the tie-in between the two. The sump is constructed first using standard well construction techniques to drill a 96 inch diameter hole to contain the 42 inch diameter polyethylene pipe sump. A European designed and fabricated trenching machine then excavates the trench, inserts the drainage pipe and backfills with aggregate in one operation. A specially designed performed pipe entry door built into the side of the sump barrel provides for efficient and safe connection of the drainage pipe to the specially designed collection sump. The effectiveness of interceptor trenches has been proven in full scale application. Reversal of flow gradients and the absolute prevention of continued horizontal migration of groundwater contaminants has been clearly demonstrated. Interceptor trenches have been shown to be cost-effective to install and operate. With the reassurance of maximum safety and an operating system that positively controls groundwater migration, interceptor trenches meet today's challenge. (See also W88-09283) (Author's abstract)
W88-09330

APPLICATION OF A GROUND-WATER-QUALITY MANAGEMENT MODEL TO THE EQUUS BEDS AQUIFER IN KANSAS,
Kansas State Geological Survey, Lawrence.
O. Drici, M. Heidari, and J. Sadeghipour.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 651-668. 8 fig, 29 ref. EPA Cooperative Agreement No. S007249 01.

Descriptors: *Water pollution treatment, *Groundwater movement, *Plumes, *Interception wells, *Kansas, *Model studies, *Groundwater management, *Groundwater pollution, Groundwater monitoring, Computer programs, Monitoring wells, Path of pollutants, Performance evaluation, Solute transport, Aquifers, Permeability coefficient, Hydraulic conductivity, Economic aspects, Groundwater, Kansas, Hydraulic models, Equus Beds aquifer, Linear systems theory, Pumping, Mathematical models.

A ground-water-quality management model was developed to investigate the best management options for the containment of an oil-field-brine plume in the Equus Beds aquifer in south-central Kansas. The model, which is based on linear-systems theory, generates unit-response functions for drawdowns and velocity vectors and, through an iterative technique, extends the applicability of these functions to large systems on minicomputers. The main objectives of this model were to find the locations and minimum rates of pumpage of plume-interception wells, to successfully reverse the velocity vectors at observation wells located along the plume front, and also to satisfy freshwater demands from supply wells. The effects of the calculated minimum withdrawals from the interception wells on the migration of contaminants throughout the ground-water system were evaluated utilizing a solute-transport model. The objective of this step was to ensure the containment of the plume. Whereas the application of these models to the study area achieved the objectives stated above, the implementation of the results is believed to be impractical and expensive. This is due to the high rates of pumpage that must be carried out to reverse the velocity vectors in the vicinity of the plume. The proposed technique of pollutant containment may be effective when applied to aquifers having low hydraulic gradients and/or to aquifers with hazardous plumes whose containment is not subject to economic considerations. (See also W88-09283) (Author's abstract)
W88-09331

MODELING REMEDIAL ACTIONS AT UNCONTROLLED HAZARDOUS WASTE SITES,
Anderson-Nichols and Co., Inc., Palo Alto, CA.
S. H. Boutwell, S. M. Brown, B. R. Roberts, and D. F. Atwood.
Noyes Publications, Park Ridge, NJ. 1986. 440 p.

Descriptors: *Water pollution control, *Water pollution treatment, *Model studies, *Cleanup operations, *Hazardous wastes, *Disposal sites, *Waste disposal, Groundwater pollution, Water pollution prevention, Mathematical models.

Modeling, whether it be through the use of relatively simple analytical solutions or more sophisticated numerical codes, is beginning to be used more and more throughout the feasibility study process. This book is intended to provide guidance on both the selection and use of a range of modeling techniques applicable to the evaluation of remedial actions for groundwater and surface water contamination problems. The book is composed of four volumes. Volume 1, Selection of Models for Remedial Action Assessment, provides a methodology for the selection of models. The methodology addresses three key decisions: (1) whether modeling should be considered; (2) if so, what level of model sophistication is appropriate; and (3) what capabilities should the model or models have. Volume 2, Simplified Methods for Subsurface and Waste Control Actions, provides a compilation of simplified methods, or analytical and semi-analytical solutions, applicable to the evaluation of subsurface and waste control actions. The primary emphasis of this volume is on identifying the methods that can be used to evaluate specific actions and the assumptions and limitations affecting their use. Volume 3, Numerical Modeling of Surface, Subsurface and Waste Control Actions, provides guidance on the use of numerical models for sites where more detailed analyses are required and where sufficient resources are available. Finally, Volume 4, Analytical and Numerical Models for the Evaluation of Surface Water Remedial Actions, provides remedial action modeling guidance for surface water contamination problems. (Lantz-PTT)
W88-09358

PROCEEDINGS OF THE 8TH NATIONAL GROUND WATER QUALITY SYMPOSIUM: 'ANATOMY OF SUPERFUND'.
National Water Well Association, Dublin, OH. September 23-25, 1986, Kansas City, Missouri. National Water Well Association, Dublin, Ohio. (1986). 147 p.

Descriptors: *Comprehensive Environmental Response Compensation and Liability Act, *Groundwater quality, *Symposium, *Superfund, *Groundwater, Water quality, Legal aspects, Management planning, Public policy.

The National Water Well Association conducted a conference entitled 'The Eighth National Ground Water Quality Symposium - Anatomy of Superfund' on September 23-25, 1986 in Kansas City, Missouri. This conference featured a broad spectrum of invited speakers from different disciplines including: state and federal attorneys; technicians from government, industry and consulting firms; and policy-makers from both the public and private sectors. The conference provided a forum for all who attended to exchange ideas and pertinent information regarding the processes and issues involved in Comprehensive Environmental Response, Compensation, and Liability Act response. These proceedings are a compilation of papers

presented by the symposium speakers. (See W88-09375 thru W88-09384) (Author's abstract)
W88-09374

SUPERFUND: SIGNIFICANT ACCOMPLISHMENTS,
ICF, Inc., Washington, DC.
For primary bibliographic entry see Field 6E.
W88-09375

CHEMICAL AND TOXICOLOGICAL ASPECTS OF SUPERFUND SITE CLEANUP,
ENVIRON Corp., Princeton, NJ.
R. H. Harris, J. V. Rodricks, and L. Brooks.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 20-37, 1 fig, 3 tab, 24 ref.

Descriptors: *Toxicology, *Water pollution treatment, *Water pollution control, *Chemical wastes, *Toxicity, *Superfund, *Cleanup operations, Organic compounds, Inorganic compounds, Path of pollutants, Solute transport, Public health, Health aspects, Chemical treatment, Risks.

Superfund sites typically contain a complex mixture of organic and inorganic chemicals. The offsite migration, or potential migration, of these chemicals is governed by the physical and chemical properties of the chemicals and of the surrounding environment. These properties may be used in analysis of the potential environmental and health risks posed by a Superfund site. The analysis, therefore, must reflect not only the chemicals deposited at the site, but also chemical and biological transformation products, and the potential for transport to off-site receptors. Because of the great number of chemicals usually found at Superfund sites, it may be necessary to choose 'indicator chemicals' for purposes of evaluating environmental and health risks. Additionally, evaluation of the toxicological properties of many chemicals is often complicated by the paucity of toxicological information. Thus, one basis for selecting indicator chemicals is the availability of toxicological data. This practice, in combination with estimates of dose-response relationships which are considered to overestimate the human response to exposure to toxic chemicals at low doses, results in health risk assessments which are believed to be conservative and protective of public health. (See also W88-09374) (Author's abstract)
W88-09376

REMEDIAL INVESTIGATIONS/FEASIBILITY STUDIES UNDER SUPERFUND,
Camp, Dresser and McKee, Inc., Atlanta, GA.
R. C. Johnson.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 40-49, 3 fig, 4 ref.

Descriptors: *Water pollution control, *Remedial investigation, *Fessibility studies, *Superfund, *Water pollution treatment, *Waste disposal, Cleanup operations, Disposal sites, Performance evaluations, Hazardous wastes, Waste management, Data acquisition.

Under Superfund, the remedial investigation (RI) generally consists of data gathering activities undertaken to determine the degree and extent of contamination associated with an uncontrolled hazardous waste site (40 CFR Part 300, 1980). The feasibility study (FS) is generally defined as the process whereby remedial alternatives are developed, screened, and evaluated in a systematic manner. EPA guidance specifies that the RI should be performed concurrently and interdependently with the FS. Preliminary evaluation of remedial alternatives is conducted during development of the RI/FS work plan, including an initial public health assessment and conceptual modeling of site contamination. This preliminary work is based on the usually substantial data available for National Priority List (NPL) sites prior to Superfund actions. RI and FS activities are interrelated so that new site screening techniques for rapid contamination assessment can provide continual data input into concurrent FS activities. Since identification of potential remedial alternatives is a component of the RI design, data collection is focused toward this goal. This process essentially eliminates unnecessary RI activities and ensures an adequate database to support the FS. (See also W88-09374) (Author's abstract)
W88-09377

SURVEYS OF REMEDIAL ACTIONS AT SUPERFUND SITES,
Soil and Material Engineers, Inc., Bordentown, NJ.
D. Pennington.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 51-60, 3 tab.

Descriptors: *Water pollution control, *Waste treatment, *Hazardous wastes, *Waste disposal, *Remedial actions, *Disposal sites, *Superfund, *Water pollution treatment, Landfills, Surveys, Reclamation, Biological treatment, Chemical treatment, United States, Cleanup operations.

The approach to response actions at uncontrolled hazardous waste sites has changed significantly since the beginning of the Superfund program. Factors influencing these changes are discussed. Phasing out of landfills, use of thermal destruction technologies, use of on-site treatment technologies, introduction of new technologies (e.g. in-situ treatment), and application of containment techniques are emphasized. Results of surveys at more than 400 hazardous waste sites throughout the United States are discussed. One conclusion of the surveys is that recent remedial actions have been more focused and comprehensive than earlier remedial actions in the Superfund program. Experience, new research and development, new technologies and/or technology transfer from other industries, public awareness and education are in part responsible for these more focused efforts. As a result, future remedial actions will need to adapt to the realities of new institutional, technological, and cost limitations. Trends in short term and long term cleanup activities include excavation and removal of contaminated materials and soils. This will become a less viable alternative as landfills capable of accepting these wastes are reduced or eliminated. Other trends discussed are increasing emphasis on on-site treatment technologies and thermal destruction technologies, potential of chemical in-situ treatment and bioreclamation, use of more advanced survey techniques reducing field time, less emphasis on temporary remedial actions, and requirements for more detailed remedial action studies and designs. Also, key problems affecting these trends (e.g., the volume of contaminated soils) are identified. (See also W88-09374) (Author's abstract)
W88-09378

ECONOMICS OF NATURAL RESOURCE DAMAGE CLAIMS,
Johns Hopkins Univ., Baltimore, MD.
For primary bibliographic entry see Field 6C.
W88-09379

U.S. EPA RESEARCH ON IN-SITU TREATMENT TECHNOLOGY,
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
For primary bibliographic entry see Field 5D.
W88-09380

ENTROPY RACES SUPERFUND,
Office of Technology Assessment, Washington, DC.
For primary bibliographic entry see Field 6E.
W88-09381

SUPERFUND - REPAIRS IN ORDER,
Delaware State Dept. of Natural Resources and Environmental Control, Dover.
M. A. Apgar, and P. S. Young.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 111-124, 2 tab.

Descriptors: *Water pollution control, *Superfund, *Cleanup operations, Management planning, Economic aspects, Risk assessment, Cost-benefit analysis, Water pollution treatment, Water quality control, Performance evaluation, Sampling, Risks, Public health.

Hazardous waste sites, even in the unconsolidated ubiquitously permeable sediments of the Atlantic Coastal Plain, have seriously contaminated few wells in Delaware. Unfortunately, the Superfund has produced studies that are time consuming, highly expensive and have thus far resulted in decisions for remedies which are unnecessary for protection of human health and the environment from significant risks. The Superfund Program should be improved by: (1) Stressing flow system delineation first, followed by limited sampling in those areas and for those constituents likely to have migrated from the waste site(s); (2) Recognizing natural contaminant attenuation linked with restriction of water supply development in those parts of aquifers anticipated to be or become heavily contaminated; (3) Recognizing water treatment as a solution to slightly contaminated wells until contamination dissipates; (4) Requiring an initial cost/benefit evaluation of replacement and avoidance of contaminated and threatened water supplies compared to costs of detailed studies and remedies, then using the result to discipline the project scope and actions; (5) Applying the program only to those sites where responsible parties can't be identified or goaded into action; (6) Allowing focused and short-cut studies of reasonably anticipated problems to reduce the length and cost of investigations; (7) Employing reasonable, as opposed to unrealistically conservative, estimates of exposure to assess risks; and (10) Support risk management decisions that are consistent with risks from other problems and with costs incurred in managing them. (See also W88-09374) (Lantz-PTT)
W88-09382

ALTERNATIVE APPROACHES TO RECORD OF DECISION,
Clean Site, Inc., Alexandria, VA.
For primary bibliographic entry see Field 6E.
W88-09383

STATE INVOLVEMENT IN AN EPA LEAD SUPERFUND REMEDIAL ACTION,
Iowa Dept. of Natural Resources, Des Moines.
T. J. O'Connor, and J. E. Carleton.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 130-147, 4 fig, 1 tab, 7 ref.

Descriptors: *Superfund, *State jurisdiction, *Cleanup operations, *Iowa, *Water pollution treatment, Bulking, Pesticides, Sludge, Waste disposal, Decontamination, Pollutant identification, National Priorities List, Water pollution sources, Soil contamination, Groundwater pollution.

The Aidex Corporation site near Council Bluffs, Iowa is a Federal-lead Superfund site. The site was included on the National Priorities List in 1981 as the state's designated top priority site. Soil and groundwater contamination resulted from spills and a 1976 fire that partially destroyed the facility. After numerous investigations at the site, a three-phase remedial action plan has been initiated at the site. Phase I includes on-site collection, bulking and temporary staging of pesticide contaminated solids, liquids and sludges; analysis of collected wastes; construction of an interceptor ditch; and disposal of bulk liquid wastes. Phase II includes disposal of all repacked drums and a large amount of debris from the site. Phase III includes excavation and disposal of all soils containing more than 10 mg/kg of all pesticides, decontamination of buildings, and capping and seeding of the site. Phases I and II have been completed. Phase III

was initiated in August 1986, and is projected to be completed by December 1986. Since remedial action is being performed using monies from the Hazardous Waste Response Fund, the State of Iowa has been involved in the decision making process and funding of the remedial actions at the site. (See also W88-09374) (Author's abstract)
W88-09384

VADOSE ZONE MONITORING FOR HAZARDOUS WASTE SITES,
Kaman Tempo, Santa Barbara, CA.
For primary bibliographic entry see Field 7A.
W88-09385

CLEAN WATER ACT PERMIT GUIDANCE MANUAL,
Smith and Schnacke, Dayton, OH.
R. S. Frye, J. W. Blattner, J. Z. Cannon, and J. N. Hanson.
Executive Enterprises Publications Co., Inc., New York. 1988. 644 p.

Descriptors: *Water pollution control, *Clean Water Act, *Permits, *Manuals, *Water quality control, Wastewater discharge, Municipal wastes, Legislation, Regulations.

Background information and guidance are provided for obtaining or renewing National Pollutant Discharge Elimination System (NPDES) permits for the direct discharge of water pollutants to surface waters. Related permit programs, such as pretreatment permits for facilities which discharge wastewater to municipal sewer systems, Underground Injection Control permits for discharge of pollutants to underground wells, or Army Corps of Engineers Section 404 permits for dredging or filling activities in waters of the United States are not covered. The present NPDES permitting program is a very complex regulatory scheme which has changed greatly in the past several years and which continues to change. Many, if not most, facilities are now operating under permits that have expired or will soon expire. As EPA and the states begin to reissue the tremendous backlog of expired permits, companies will need to understand the requirements of the current rules and be aware of the favorable changes which might be available within the next few months. The first portion of the text (Parts II and III) addresses what is contained in a permit -- effluent limitations and other conditions -- while the second portion of the texts (Parts IV and V) addresses the procedures for obtaining, modifying, and terminating NPDES permits. Part VI explains the legal liability which you may have for a discharge even if you have an NPDES permit. To supplement the text, Appendices have been provided which give more detailed discussion of certain of the more important or more complicated issues involved in NPDES permitting. (Lantz-PTT)
W88-09399

REMEDIAL TECHNOLOGIES FOR LEAKING UNDERGROUND STORAGE TANKS,
Weston (Roy F.), Inc., Concord, CA.
Lewis Publishers, Chelsea, Michigan. 1988. 216 p.

Descriptors: *Water pollution treatment, *Cleanup operations, *Storage tanks, *Underground storage, Leakage, Water pollution prevention, Groundwater pollution, Feasibility studies, Biodegradation, Volatilization, Isolation, Solidification.

The prevention, detection, and correction of leakage of petroleum products from underground storage tanks (UST) has gained high priority in the utility industry and within the regulatory agencies. The 1984 amendments to the Resource Conservation and Recovery Act (RCRA) require the U.S. Environmental Protection Agency (EPA) to develop new Federal regulations for reducing and controlling environmental damage from underground storage tank leakage. This report provides a general introduction to the state-of-the-art of cleanup technology, including a listing of feasible methods, a description of their basic elements, and some discussion of the factors to be considered in their selection and implementation for a remedial program. This report is not intended to be a remediation design and implementation manual. All soil and groundwater remediation problems require site-specific considerations in choosing, designing, and implementing the most appropriate remedial programs. The information in this report is organized and presented in terms of four major considerations in evaluating the relative feasibility of each method: technical feasibility, implementation feasibility, environmental feasibility, and economic feasibility. Remedial technologies discussed are: volatilization, biodegradation, leaching and chemical reaction, vitrification, passive remediation, isolation/containment, land treatment, thermal treatment, asphalt incorporation, solidification/stabilization, groundwater extraction and treatment, chemical extraction, and excavation. (Lantz-PTT)
W88-09402

REHABILITATING DAMAGED ECOSYSTEMS.
For primary bibliographic entry see Field 5C.
W88-09448

RESTORATION ECOLOGY: THE NEW FRONTIER,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
J. Cairns.
IN: Rehabilitating Damaged Ecosystems. Volume I. CRC Press Inc., Boca Raton, Florida. 1988. p 1-11, 5 ref.

Descriptors: *Cleanup operations, *Management planning, *Restoration, *Water pollution control, *Water pollution treatment, *Rehabilitation, *Water pollution effects, *Ecological effects, *Waste disposal, Ecosystems, Wetlands, Hazardous wastes, Disposal sites, Water pollution prevention, Groundwater pollution.

If a natural system is altered, its ecological role is either eliminated or substantially changed. In some cases, such as alteration due to surface mining, some formerly existing ecological characteristics may be replaced relatively quickly and others may take more than a human lifetime to restore. In other cases, such as the construction of condominiums, high-rise buildings, football stadiums, etc., the alteration is permanent from the perspective of the human lifetime. A high probability exists that some artifacts will be replaced with larger, more formidable artifacts rather than the original ecosystem. This paper focuses on the restoration or rehabilitation of ecosystems subjected to a disturbance following which remedial measures may be immediately instituted. Even in cases where the intention is to build artifacts that will alter the ecosystem for tens or hundreds of years, consideration should be given to the options for alternative use when the life expectancy of the present artifact has been reached. Damaged ecosystems can often be used for partially replacing systems lost elsewhere. Abundant evidence is given that surface mined land can be used to create wetlands where none existed before. Since natural wetlands are being lost to agriculture (about 80% of the loss) and for building construction and other purposes (20%) at a frightening rate, the replacement of many of their functions elsewhere has positive features. In the case of hazardous waste sites, several major options are available: (1) Detoxify the site and restore to original condition or some alternative ecologically stable condition; (2) At sites where option 1 may be technologically impossible, or cost prohibitive, the primary objectives would be to exclude the general public, migratory water fowl, and so on to reduce or eliminate the chances of inadvertent exposure to hazardous materials and to immobilize the waste so that adjacent areas are not contaminated; (3) To remove and treat those portions of the hazardous waste still in a relatively concentrated form and to leave the partially dispersed and transformed wastes that are difficult to collect and treat on the site until natural transformations continue; and (4) To reduce the hazard or risk to a level considered acceptable to society and then to restore the site to either original condition or to some alternative ecosystem (such as a wetland) that would be acceptable to society. (See also W88-09438) (Lantz-PTT)
W88-09449

RIVER AND STREAM RESTORATION,
Tulsa Univ., OK. Faculty of Biological Science.
J. A. Gore, and F. L. Bryant.
IN: Rehabilitating Damaged Ecosystems. Volume I. CRC Press Inc., Boca Raton, Florida. 1988. p 23-38, 2 fig, 2 tab, 73 ref.

Descriptors: *Rivers, *Streams, *Restoration, *Cleanup operations, *Ecosystems, *Water pollution control, *Rehabilitation, *Water pollution treatment, Ecological effects, Urban runoff, Riparian vegetation, Lotic environment, Fish, Channels.

Though rivers and streams represent a small portion of available freshwater (<0.02%), the natural replenishment of this component of the hydrologic cycle (often 2 weeks) has caused humans to perceive this resource as more available and less destructable. In turn, overuse and misuse of streams and rivers have resulted in severe damage to the ecosystems associated with running water systems. Ecosystem damage can take on such subtle characteristics such as increased sediment loads, poor water quality from urban runoff, and unobserved declines of habitat and production of game and nongame species. Unlike terrestrial reclamation or restoration projects, river restoration must also account for systems that interact to produce the lotic ecosystem. That is, pollutant loads from surface runoff must be reduced or eliminated and riparian vegetation must be restored to control erosion and to provide habitat for riparian fauna that also use lotic resources. Within the restored channel, a number of hydrologic considerations must be examined. Because discharge patterns are fairly predictable, channel configuration can be designed to simulate meander and depositional patterns. In addition, bank and bed stability must be planned and structures built. Both fish and their food sources, mostly from the benthic community, must also be restored. Since river restoration rarely involves direct transplantation or introduction of animal species, habitat structures should be designed to attract residents from colonizers arriving from upstream and downstream areas. Thus, 'reclamation' of the instream flora and fauna is a process of habitat and colonization enhancement. (See also W88-09438) (Lantz-PTT)
W88-09450

RECLAMATION AND TREATMENT OF CONTAMINATED LAND,
Bostock, Hill and Rigby Ltd., Birmingham (England).
M. A. Smith.
IN: Rehabilitating Damaged Ecosystems. Volume I. CRC Press Inc., Boca Raton, Florida. 1988. p 61-89, 10 fig, 5 tab, 57 ref.

Descriptors: *Land reclamation, *Rehabilitation, *Cleanup operations, Soil contamination, Water pollution sources, In-situ treatment, Macroencapsulation, Isolation, Containment, Monitoring.

'Contaminated land' can be defined as 'land that contains substances that, when present in sufficient quantities or concentrations, are likely to cause harm, directly or indirectly to man, to the environment, or on occasions to other targets.' The contamination of land has become of major concern during the past decade in both North America and Europe for three major reasons: (1) Actual and potential risk to human health and safety through, for example, contaminated water supplies or foodstuffs; (2) Actual and potential damage to the natural environment; and (3) Inhibition of the beneficial use of land for agriculture, residential, amenity, or industrial purposes. Discussions about options available for remedial action (appropriate, long-term measures), soil treatment after excavation, in-situ treatment, macroencapsulation/isolation/containment, monitoring and evaluation of performance, and building on contaminated land, present the various techniques for the reclamation of contaminated land. (See also W88-09438) (Lantz-PTT)
W88-09452

TECHNIQUES FOR THE CREATION OF WETLAND HABITAT IN COAL SLURRY PONDS,
Restoration Resources, Inc., Indianapolis, IN.

C. S. Thompson.
IN: Rehabilitating Damaged Ecosystems. Volume I. CRC Press Inc., Boca Raton, Florida. 1988. p 91-114, 17 fig, 4 tab, 14 ref.

Descriptors: *Wetlands, *Mine wastes, *Water pollution treatment, *Habitats, *Coal mines, *Slurry ponds, *Reclamation, Cyclone separation, Multiple discharge method, Soil water, Soil chemistry.

Coal slurry is the by-product of the coal cleaning process. It consists of fine coal particles and other constituents such as pyrite, calcite, sand, and clay ranging in size from +60 to -250 mesh. Pyrite is, of course, an undesirable element due to its tendency to be converted to sulfuric acid under natural weathering conditions. For this reason slurry disposal ponds have in the past been considered pollution sources to be eliminated by covering with a nontoxic soil material. The result has been creation of federal regulations requiring the coal mine operator to cover all slurry ponds with 4 ft of suitable soil material. In reality, however, 6 to 8 ft is often required in order to operate heavy, earth-moving equipment on such soft material as slurry. This means hundreds of thousands to several million dollars may be required to reclaim a single slurry pond. Higher reclamation costs have, in recent years, caused more attention to be given to the natural soil constituents that occur in the slurry itself. The one basic element that this soil lacks is fertility which may be supplemented with artificial fertilizer and nurse crops until such time that organics in the soil become self-sustaining through plant material growth and death cycles. Another important element of a slurry pond is the soil moisture availability. Most slurry ponds have a substantial portion of the acreage in shallow standing water and saturated soils typical of most inland wetlands. Therefore, with the elimination of acid conditions and addition of fertilizer and plant materials, the low wet areas of a slurry pond can be converted to wetland habitat while the dryer areas may be planted to supportive upland vegetation. All of this may be accomplished with limited soil cover resulting in a substantial cost savings to the mine operator and assuring elimination of a potential pollution source. Of equal importance is the creation of wetland/wildlife habitat. This chapter discusses three types of management practices and actual field trials of these methods: (1) Ayrshire mine slurry project at a pre-existing slurry basin; (2) cyclone separation; and (3) multiple discharge method. (See also W88-09438) (Lantz-PTT)
W88-09453

EVALUATION OF STRIP PITS AND PONDS FOR PHYSICAL MANIPULATION TO INCREASE WETLANDS AND IMPROVE HABITAT IN SOUTHWESTERN INDIANA,
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 2H.
W88-09454

SALT MARSH RESTORATION: LESSONS FROM CALIFORNIA,
San Diego State Univ., CA. Dept. of Biology.
For primary bibliographic entry see Field 2L.
W88-09455

RESTORATION AND MANAGEMENT OF ECOSYSTEMS FOR NATURE CONSERVATION IN WEST GERMANY,
Stuttgart Univ. (Germany, F.R.). Inst. fuer Landschaftsplanung.
D. Bruns.
IN: Rehabilitating Damaged Ecosystems. Volume I. CRC Press Inc., Boca Raton, Florida. 1988. p 163-186, 2 fig, 4 tab, 70 ref.

Descriptors: *Restoration, *Ecosystems, *West Germany, *Hydrologic cycle, *Lake restoration, *Conservation, *Regulations, Transplantation, Implantation, Colonization, Wildlife, Water supply, Flooding, Biomass, Case studies.

Restoration of disturbed land and water has a long tradition in West Germany. Even with the construction of the first Autobahns, ecological factors in the existing landscape were taken into consideration and special seed mixtures were chosen for seeding the highway embankments. Most recently, the restoration of ecosystems as habitat for indigenous animals and plants is rapidly gaining importance under the specific ecological and socio-legal conditions of central Europe. As a result of massive losses of certain species and ecosystems, public pressure is turning toward both conservation and restoration, and new laws have been passed. A discussion of management options for the restoration of ecosystems include: (1) transplantation; (2) implantation (partial transplantation); (3) natural colonization; (4) regulation of the water regime; (5) reclamation of flooded gravel pits for lake development; and (6) removal of biomass. Two case studies are given as examples of restoration projects. (See also W88-09438) (Lantz-PTT)
W88-09456

REHABILITATING DAMAGED ECOSYSTEMS.
Volume II. CRC Press, Inc., Boca Raton, Florida. 1988. 222 p. Edited by John Cairns.

Descriptors: *Ecological effects, *Cleanup operations, *Rehabilitation, *Water pollution treatment, *Water pollution control, *Restoration ecology, Wetlands, Mount Saint Helens, Water quality, Ecosystems, Patuxent River, Management planning, Volcanoes, Costs, Mining, Political aspects, Social aspects, Altitude, Alpine regions.

Future management options for the rehabilitation of damaged ecosystems will be dramatically affected research opportunities in ecosystems that industry is charged with rehabilitating, or in derelict ecosystems where government must accept this responsibility since it is legally impossible to assign responsibility to an individual or a private institution. The young and rapidly developing field of restoration ecology has evolved to a sufficient degree to enable cost-effective and ecologically interesting restoration of ecosystems damaged by mining and other anthropogenic activities. It is important for research investigators, regulators, industries, and other organizations charged with rehabilitation to realize that they have a common interest but that all will have to adjust to the needs of the others in order to achieve the desired results. These desired results should be: (1) a cost-effective means of fulfilling the responsibility of rehabilitating the damaged ecosystems so that those charged with this responsibility meet the legal requirements for doing so; (2) the regulators must be able to demonstrate that they have fulfilled their responsibility to the public and to their superiors in the government at whatever level of government they represent; and (3) the research investigators must derive sufficient new information to justify publication in a peer-reviewed scholarly journal. This volume addresses: (1) ecosystems at Mount St. Helens; (2) alternative endpoints for reclamation; (3) water quality-based controls and ecosystem recovery; (4) political and social factors in the Patuxent River cleanup agreement; and (5) rehabilitating ecosystems at high altitudes. (See W88-09458 thru W88-09462) (Lantz-PTT)
W88-09457

RE-CREATION OF ECOSYSTEMS AT MOUNT ST. HELENS: CONTRASTS IN ARTIFICIAL AND NATURAL APPROACHES,
Washington Univ., Seattle. Coll. of Forest Resources.
J. F. Franklin, P. M. Frenzen, and F. J. Swanson.
IN: Rehabilitating Damaged Ecosystems. Volume II. CRC Press, Inc., Boca Raton, Florida. 1988. p 1-37, 17 fig, 5 tab, 48 ref.

Descriptors: *Mount Saint Helens, *Ecosystems, *Rehabilitation, *Cleanup operations, *Reforestation, *Volcanoes, National parks, Fish, Wildlife, Forests, Streams, Trees, Washington, Tephra, Cascade Range, Management planning.

The eruption of Mount St. Helens on May 18, 1980 devastated more than 500 sq km of mountainous forest lands and associated streams and lakes in the southern Washington Cascade Range. Tephra deposits from the eruption blanketed a much larger area, including thousands of square kilometers of forests and meadowlands in the southern Cascade Range and extending across eastern Washington into western Montana. Approaches to rehabilitation of affected lands are contrasted for areas committed primarily to commodity production and those committed to scientific and recreational purposes, primarily within the Mount St. Helens National Volcanic Monument (the Monument) created by Congress in 1982. Watershed, timber, wildlife, and fish resources are being artificially rehabilitated outside the Monument, whereas natural recovery processes predominate on Monument lands. Outside of the Monument humans are clearly increasing the rate at which many areas altered by Mount St. Helens will recover to preeruption conditions of function, structure, and composition. This is particularly notable on the most severely disturbed sites where human activities can short circuit limitations of seed supply and difficulties of seedling establishment. Tree planting is one of the most significant activities in terms of its contribution to rapid reestablishment of a fully functional forest. Establishment of closed forest conditions will take many decades and, in some cases, 1 or 2 centuries on sites within the Monument where seed supply and environmental conditions for seedling establishment are limiting. Areas where tree seedlings and saplings were protected by snow will provide the major exception to slow forest reestablishment within the Monument. Human activities that reintroduce other organisms, such as fish, and create critical structures or specialized habitats, such as tree cavities, also strongly influence recovery of higher trophic levels. Excessive focus on a single objective or organism is likely to lead to problems of this sort; in selecting measures for restoration of ecosystems it is important to thoroughly consider effects on nontarget processes or organisms. (See also W88-09457) (Lantz-PTT)
W88-09458

WATER QUALITY-BASED CONTROLS AND ECOSYSTEM RECOVERY,
Environmental Protection Agency, Washington, DC. Monitoring and Data Support Div.
J. L. Plafkin.
IN: Rehabilitating Damaged Ecosystems. Volume II. CRC Press, Inc., Boca Raton, Florida. 1988. p 87-96, 3 tab, 28 ref.

Descriptors: *Regulations, *Ecosystems, *Water pollution control, *Self-purification, *Reclamation, Toxicity, Hazardous wastes, Monitoring, Bioassay, Bioaccumulation, Management planning, National Pollution Discharge Elimination System, Environmental Protection Agency, Standards, Bioassays, Model studies.

A new toxics guidance is the first comprehensive attempt of the Environmental Protection Agency to include the concept of ecosystem-level hazard assessment in the water quality-based control process. The Technical Support Document describes an integrated strategy for implementing new water quality criteria in National Pollution Discharge Elimination System (NPDES) permits using both biomonitoring (effluent bioassays, ambient biological surveys) and chemical-specific (individual pollutant) modeling techniques. Also for the first time, an ecological rather than an operational rationale is presented for defining critical parameters for exposure and waste load allocation modeling. This paper summarizes the background for developing this rationale and describes how ecosystem recovery is now being considered in defining and implementing water quality criteria. (See also W88-09457) (Lantz-PTT)
W88-09460

POLITICAL AND SOCIAL FACTORS IN THE PATUXENT RIVER CLEANUP AGREEMENT,
ERM, Inc., Exton, PA.
P. N. Klose, E. L. Rich, and P. Schneider.
IN: Rehabilitating Damaged Ecosystems. Volume II. CRC Press, Inc., Boca Raton, Florida. 1988. p 97-103, 1 fig, 1 tab, 5 ref.

Descriptors: *Political aspects, *Social aspects, *Patuxent River, *Cleanup operations, *Eutrophication, *Mediation, *Estuaries, *Rivers, *Water pollution control, Fisheries, Federal jurisdiction, Advanced wastewater treatment, Wastewater treatment, Regulations, Nitrogen, Phosphorus, Chlorine, Nutrients, Water pollution prevention.

Political and social considerations can play as large a role in the restoration of damaged ecosystems as ecological or economic factors. A classic example of this is shown in the decade-long statement between two groups concerned in the Patuxent River nutrient control controversy. Court action by a coalition of scientists, county officials, and watermen (commercial fishermen) linked U.S. Environmental Protection Agency (EPA) sewerage construction grant money to the completion of a plan for controlling nutrient discharges into the Patuxent. Political pressure to clean up the river quickly intensified when local officials were faced with the prospect of losing $29 million in federal wastewater treatment plant funds. A further controversy arose over the need for phosphorus control vs. nitrogen control as the preferred advanced wastewater treatment method for reducing eutrophication in the Patuxent. To resolve this conflict, the state worked through the Patuxent River Commission and selected a consultant to mediate the conflict. In fall of 1981, a process to resolve the water quality dispute was initiated, culminating in a 56-hr mediation session, referred to as a charrette. The current status of the Patuxent River is that some moderate improvement in certain water quality parameters has been evidenced. Land treatment of sewage effluent is being used by some projects in the area, both for sewage treatment plants and large housing developments. Removing phosphorus from sewage effluent is agreed upon by all parties as a major path to improving the freshwater portions of the river. However, controversy continues to exist over whether it will do much good in the saltier lower river where a different chemistry is at work. (See also W88-09457) (Lantz-PTT)
W88-09461

REHABILITATING ECOSYSTEMS AT HIGH ALTITUDES,
Western State Coll. of Colorado, Gunnison.
H. A. Ferchau.
IN: Rehabilitating Damaged Ecosystems. Volume II. CRC Press, Inc., Boca Raton, Florida. 1988. p 193-209, 129 ref.

Descriptors: *Rehabilitation, *Revegetation, *Ecosystems, *Mine wastes, *Land reclamation, *Alpine regions, Climates, Seasonal variation, Economic aspects, Soil management, Seeding, Mountains, Grasses, Sewage sludge, Hay.

Reclamation and revegetation in the high mountains is shifting from a dormant mining industry to considering old and abandoned mines hazardous to humans. Work persists in this revegetation of roadsides, quarries, and any other activity not associated with a downed economy. A ranching and farming industry that is being subjected to an economic test may result in a revegetation effort of infinitely greater acreage than what has been previously considered. The difficulty will be associated with a lack of available funding. Functional problems are primarily associated with site variability in soils and topography. The ultimate problems are attributable to a climate that is annually abnormal. Surface reestablishment requires ingredients for a productive soil. These are: straw; hay; sawdust; sewage sludge; a mixture of sewage sludge, sawdust and hay; hydromulch (such as aspen fiber, grass stubble residue and/or paper); netting; equipment; seed; and plant materials. The actual sequence of events for revegetation consist of: (1) site preparation; (2) seeding; (3) transplants; and (4) irrigation. (See also W88-09457) (Lantz-PTT)
W88-09462

PROCEEDINGS OF THE FOURTH ANNUAL EASTERN REGIONAL GROUND WATER CONFERENCE.
For primary bibliographic entry see Field 4B.
W88-09477

WELLHEAD PROTECTION IN EASTERN STATES: PROGRAM BASES AND PROSPECTS,
Dames and Moore, Bethesda, MD.
For primary bibliographic entry see Field 4B.
W88-09478

MANAGEMENT OF TOXIC AND HAZARDOUS MATERIALS IN A ZONE OF CONTRIBUTION ON CAPE COD,
Massachusetts Dept. of Environmental Quality Engineering, Boston.
T. Gallagher, and L. Steppacher.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 13-41, 4 fig, 7 tab, 16 ref.

Descriptors: *Groundwater management, *Groundwater pollution, *Toxic wastes, *Water pollution control, *Water pollution treatment, *Waste disposal, *Hazardous materials, Aquifer management, Storage tanks, Leachates, Leakage, Path of pollutants, Water pollution prevention, Water pollution control, Management planning, Organic wastes.

The Cape Cod Aquifer Management Project (CCAMP), a two year collaborative effort by MADEQE, EPA Region I, the Cape Cod Planning and Economic Development Commission (CCPEDC) and USGS to develop improved methods of groundwater protection at all levels of government, has initiated an intensive inventory of land uses in one zone of contribution (ZOC) to a group of public supply wells. This detailed study has provided the forum for CCAMP's consideration of the effectiveness of existing regulatory programs and of management options for wellhead protection areas. located in the Town of Barnstable and extending into neighboring Yarmouth, the study area contains several current and future public supply wells yet is highly developed. A large number of commercial businesses, an industrial part, the Hyannis Airport, the municipal wastewater treatment plant and residential areas are all present. This ZOC contains most of the types of commercial and industrial businesses present on the Cape and so provides an excellent example for an analysis of toxic and hazardous materials management in Cape towns. Information from regulatory programs at the federal, state and local levels was utilized to identify all the potentially polluting materials stored or disposed of at each site. A description of the sources of data best able to provide critical information on specific businesses is presented and their limitations described. The overall presence of toxic and hazardous material in the Zone is summarized and the risk to present and future well sites is examined. The comprehensive protection of toxic and hazardous materials that exists on paper is contrasted to the patchwork protection observed. Options are presented for the resolution of these program inadequacies. (See also W88-09477) (Author's abstract)
W88-09479

MANAGING GROUND WATER IN MAINE: THREE APPROACHES,
Gerber (Robert G.), Freeport, ME.
For primary bibliographic entry see Field 4B.
W88-09481

UPPER NEPONSET VALLEY AQUIFER STUDY: INTEGRATING GROUND WATER QUALITY PROTECTION WITH CONTAMINATION INVESTIGATIONS,
Massachusetts Dept. of Environmental Quality Engineering, Boston.
R. M. Crystal, D. D'Amore, and R. W. Heeley.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 81-109, 11 fig, 11 ref.

Descriptors: *Groundwater management, *Water quality control, *Water pollution prevention, *Massachusetts, *Model studies, *Hydrologic maps, Test wells, Monitoring, Geohydrology, Aerial photography, Path of pollutants, Aquifers, Groundwater pollution, Computers, Soil contamination, Groundwater recharge.

The Upper Neponset Valley Aquifer Study, conducted by the Massachusetts Department of Environmental Quality Engineering, Division of Water Supply, demonstrates how groundwater quality protection can be integrated with contamination investigations. The study combined many techniques to define the sources and extent of organic chemical contamination of three water supplies: Norwood's Ellis wellfield; the White Lodge wellfield of the Dedham-Westwood Water District (formerly the Dedham Water Company); and Canton's well number 7. Of equal importance were prevention of future contamination by developing a regional hydrogeologic database; technical assistance to local governments; and coordination with state hazardous waste regulation. Relevant hydrogeologic data were displayed on a set of maps of common scale. A computerized database of all monitoring wells in the study area was created. Aerial photographic interpretation, questionnaires, and site visits were used to identify land uses with likely chemical releases. Conceptual models prepared for each study area included delineating wellhead protection primary recharge areas (Zone II) for the three major wellfields. Hydrogeologic conditions were investigated with seismic refraction, electrical resistivity and gravity methods. Monitoring wells were drilled into suspected contaminant plumes, with screen depth selection based on portable gas chromatograph analyses of soil samples obtained during drilling. Groundwater flow patterns and aquifer/stream interactions were linked to probabilities of contaminant transport from likely sources to production wells. Under Massachusetts General Law Chapter 21E, the study results are being used to support planning in discovery of remedial actions in response to hazardous material releases. The observation well database will be used in establishing a statewide database. (See also W88-09477) (Author's abstract)
W88-09483

FLORIDA - PROVIDING INCENTIVE FOR REPORTING LEAKS,
Florida State Dept. of Environmental Regulation, Tallahassee.
C. Ash, S. Gray, and C. Garrett.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 113-119, 9 ref.

Descriptors: *Oil pollution, *Florida, *Water pollution prevention, *Storage tanks, *Water quality control, Groundwater management, Cleanup, Legal aspects, Cost sharing, Public health, Leakage, Groundwater pollution, Maintenance.

The State Underground Petroleum Environmental Response (SUPER) Act of 1986 is an important part of the comprehensive legislation passed by the Florida Government to protect Florida's groundwater resources. The SUPER Act and the Stationary Tanks Rule together provide for inspection of new petroleum storage tank installations, maintenance and monitoring of tanks that are in operation, and incentives for reporting discharges in the form of state funding for site cleanup or cleanup reimbursement. The specific intent of the SUPER Act is to protect Florida's critical groundwater resources. By minimizing the number of petroleum contamination sites, the health risks associated with contamination sites are lessened. Public safety and welfare are also protected in cases of petroleum contamination by having established procedures for dealing with the repair or replacement of contaminated potable water systems. Response to the SUPER Act's incentive providing programs are encouraging: 1,687 applications for state initiated cleanups or reimbursement of cleanup costs were received as of June 1, 1987. (See also W88-09477) (Author's abstract)
W88-09484

FEDERAL CORRECTIVE ACTION REQUIREMENTS FOR PETROLEUM UNDERGROUND STORAGE TANKS,
ICF, Inc., Washington, DC.
G. Back, D. Bauer, and R. Valentinetti.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 121-131, 1 fig.

Descriptors: *Storage tanks, *Oil pollution, *Leakage, *Groundwater pollution, *Cleanup, Water pollution prevention, Water pollution control, Legal aspects, Path of pollutants, Public health, Risks, Groundwater management.

The USEPA has proposed federal requirements on owners and operators of petroleum underground storage tanks (USTs) for corrective action in response to above and below ground releases. These regulations were issued pursuant to Subtitle I of RCRA and are expected to be finalized in the Spring of 1988. Responsibility for implementing corrective action (and the associated reporting requirements) falls to petroleum UST owners and operators (except under limited conditions) with oversight by authorized states. Owners and operators must take steps to achieve some cleanup in all cases through a series of immediate abatement actions, and to pursue additional longer-term corrective action in cases where state standards are exceeded or where the remaining risk to human health and the environment, estimated through a site-specific exposure and risk assessment, is deemed unacceptable. The implementing agency is given the responsibility of conducting this assessment, which is used to set site-specific clean-up levels for all affected media, or it may authorize an UST owner or operator to conduct the assessment. (See also W88-09477) (Author's abstract)
W88-09485

CASE STUDY OF A LARGE SCALE PRECISION TANK TESTING PROGRAM,
Tetra Tech Richardson, Newark, DE.
D. H. Heck.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987.. National Water Well Association, Dublin, OH. 1987. p 133-144, 3 fig, 3 ref.

Descriptors: *Storage tanks, *Oil pollution, *Groundwater pollution, *Leakage, *Corrosion, Water pollution prevention, Water pollution control, Groundwater management, Maryland, Legal aspects, Case studies.

In September of 1986, a precision tank testing program was started to bring a major Maryland utility into compliance with the State of Maryland Oil Spill Control regulations regarding underground storage tanks. This program involved the testing of over 240 tanks ranging in size from 300 gallons to 1,500 gallons located throughout the entire state of Maryland. Analyses of the testing results revealed that 40% of the systems tested leaked. Piping leaks caused 82% of the testing failures and tank leaks caused the remaining 18%. Tank systems located in urban areas experienced a 50% testing failure rate, while tank systems located in rural areas experienced only a 25% failure rate. Leaks in tank systems in urban areas appear to be the result of structural loading and corrosion, affects absent in rural areas. The age, capacity, and usage of the tank systems did not have a role in causing leaks either in the piping or the tank. (See also W88-09477) (Author's abstract)
W88-09486

DESIGN CONSIDERATIONS FOR UNDERGROUND STORAGE TANK INSTALLATIONS REQUIRING SECONDARY CONTAINMENT: A CASE STUDY,
Benatec Associates, Inc., Harrisburg, PA.
K. D. Svitana, and J. K. Palmer.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 145-158, 8 fig, 2 ref.

Descriptors: *Groundwater pollution, *Storage tanks, *Leakage, *Water pollution prevention, *Design criteria, Pennsylvania, Case studies, Groundwater management, Cost analysis, Monitoring, Oil pollution, Hazardous materials.

The Underground Storage Tank regulations, which have been enacted in several states and are pending nationally, are a result of an increased awareness of soil and aquifer protection from petroleum and hazardous material leaks. There are several permissible design options available for providing secondary containment for underground storage tanks. The design and cost analysis for secondary containment of underground tanks at a large trucking terminal located in an area underlain by extensively fractured limestone is presented. Groundwater drainage at the trucking terminal was via conduit flow to a cold freshwater stream known nationally for its fisheries. The secondary containment options were designed to provide maximum containment and detect any spilled or leaked product. Design features also incorporated the means by which lost product could be recovered. Three containment designs and cost criteria were evaluated: (1) double walled tanks, (2) single walled tanks with a concrete vault, and (3) single walled tanks with a synthetic liner for containment. For each of the designs, consideration was given to types of monitoring leak detection and recovery, and total containment. The results of the design and costs evaluation indicated that for the subsurface conditions (fractured limestone bedrock), a sealed concrete vault would be the most effective method of containment for a tank farm installation. For individual tanks, containment was best met by utilizing double walled tanks. Continuous monitoring devices were utilized for both the tank farm and individual tank installations. (See also W88-09477) (Author's abstract)
W88-09487

RISK DRIVEN SITE INVESTIGATIONS: TWO CASE STUDIES OF LEAKING UNDERGROUND STORAGE TANKS,
Camp, Dresser and McKee, Inc., Boston, MA.
J. M. Henderson, W. A. DiTullio, and P. M. Williams.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 161-179, 6 fig, 8 ref.

Descriptors: *Storage tanks, *Leakage, *Groundwater pollution, *Models, *Case studies, Risks, Monitoring, Site selection, Oil pollution, Public health, Path of pollutants, Project planning, Model studies, Oil spills, Water pollution prevention.

Leaking underground storage tanks are one of the most pervasive environmental problems facing consulting engineers and regulatory agencies. Statistics indicate that the number of leaking tank incidents can be expected to increase significantly in the coming years. There are limited economic and manpower resources available to address this burgeoning problem. A risk driven methodology can be used to focus these limited resources effectively when designing field investigation programs at known or suspected contamination sites. A description of the risk driven approach showing the iterative process of problem conceptualization, risk assessment, data collection, and revision of the conceptual model of the problem is presented. Two case studies (the County Jail oil spill and the North Common Heating Plant oil spill) are used to demonstrate how this method has been used to effectively investigate leaking underground storage tanks. (See also W88-09477) (Author's abstract)
W88-09488

APPLICATION OF THE SOIL-GAS SURVEY TO UNDERGROUND STORAGE TANK MONITORING AND LEAK DETECTION,
Hydrosystems, Inc., Falls Church, VA.
For primary bibliographic entry see Field 5A.
W88-09490

UNDERGROUND STORAGE TANK REMOVAL AND TREATMENT OF CONTAMINATED SOILS,
Law Environmental, Inc., Kennesaw, GA.
J. M. Maroncelli, M. D. Schmieder, and T. F. Sliva.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 207-215, 1 fig, 13 ref.

Descriptors: *Storage tanks, *Groundwater pollution, *Water pollution treatment, *Path of pollutants, *Cleanup, Soil contamination, Organic compounds, Cleanup operations, Groundwater management, Water pollution control, Regulations.

The new EPA rules for underground storage tanks (UST's) which will go into effect in the spring of 1988 will make removal or abandonment of UST's an attractive alternative to many businesses that do not need underground storage facilities. Most regulatory agencies will permit two types of tank closures: removal from the ground or closure in place. The owner or operator must assess the site for contamination when a tank closure is performed. To complete a tank removal safely, several precautions should be considered. First, information on the tanks to be removed should be gathered. Several contractors should be interviewed to find one experienced in the type of removal required. All underground utilities in the excavation area should be located and marked by the utility companies. Material and/or sludge contained in the tanks should be removed. All fill and vent lines should be cleaned and removed. The tank should be purged of all volatile vapors by water or air. Samples of the underlying soils should be obtained and analyzed upon completion of the tank removal operations. If corrective action is needed to reduce the concentration of contaminants remaining in the soil, a selection must be made of the most cost-effective method which will protect human health and the environment. Treatment options include biological or chemical treatment or burial in an approved landfill. (See also W88-09477) (Geiger-PTT)
W88-09491

CORRECTIVE ACTION TECHNOLOGIES AND THEIR COST-EFFECTIVENESS,
Camp, Dresser and McKee, Inc., Boston, MA.
J. T. Curtis, and D. C. Noonan.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 217-243, 5 fig, 147 ref.

Descriptors: *Gasoline, *Leakage, *Groundwater pollution, *Cleanup operations, *Soil contamination, *Water pollution treatment, Storage tanks, Path of pollutants, Microbial degradation, Water pollution prevention, Water pollution control, Cleanup.

A release from an underground storage tank may cause extensive contamination of the soil and the groundwater. Minimizing the environmental damage from such a release requires a comprehensive approach to develop a corrective action plan which addresses all phases of contamination. Gasoline spilled or leaked into soil volatilizes due to its high vapor pressure and fills pore spaces with its vapors. Gasoline vapors present in soil, as well as gasoline present in soil in the liquid phase, are subject to further dispersal and migration as precipitation moves into and through soils. Gasoline in either of these states can become dissolved in water and eventually move into groundwater supplies. Therefore, it is important under any corrective action scenario that gasoline present in unsaturated soils, as well as that present as free product and that dissolved in groundwater, be removed to minimize further dispersal of the contaminants. Free product recovery is essential as a first step to remove the source of contamination. Recovery of gasoline as pure product is the most cost-effective method of removing the contaminant. Trenches or pumping wells can be used to contain the spread of

floating gasoline. The product can then be removed with skimmers, filter separators, recovery pumps, or oil-water separators. Soil must be treated to prevent recontamination by percolant precipitation. Many methods of soil treatment are available, and include excavation and disposal, incineration, soil washing, enhanced volatilization, soil venting, and microbial degradation. Removing gasoline dissolved in groundwater normally involves air stripping, carbon adsorption, biodegradation, or a combination of these methods. All of these corrective actions differ in their applicability, their effectiveness, their costs, and limitations. A good understanding of the various techniques is necessary in order to develop an effective, comprehensive plan. (See also W88-09477) (Author's abstract)
W88-09492

IS PRIVATE WELL PROTECTION ADEQUATE WHEN GROUND WATER FLOW IS IGNORED,
K-V Associates, Inc., Falmouth, MA.
W. B. Kerfoot.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 291-314, 14 fig, 3 tab, 13 ref.

Descriptors: *Path of pollutants, *Groundwater pollution, *Water pollution control, *Leaching, *Water pollution sources, *Wells, Water pollution prevention, Groundwater movement, Leachates, Flow measurement, Iron, Ammonia, Nitrates, Flow velocity, Septic tanks.

A study of wells in the Town of Falmouth on Cape Cod conducted in the summer of 1982 indicated high levels of iron, ammonia, and nitrate-nitrogen in numerous wells. A majority of wells were impacted by groundwater polluted by wastewater leachate from the owner's or a near-neighbor's lot. The region adjacent to Mares Pond contained 29 out of 44 homes with elevated pollution indicators. This area exhibited rapid groundwater flow, and contained soils consisting largely of sand and gravel. The orientation of the septic system relative to the well and groundwater flow was an important determinant in well pollution. To determine how representative the local groundwater flow was of a broader area, over 102 separate determinations of flow were made in residential developments throughout the town over a four-year period. A frequency diagram of the flow velocities revealed a mode of 1.2 ft/day, a median of 2.0 ft/day and a mean velocity of 2.5 ft/day. Consistently higher velocities were found near upgradient or downgradient areas of abundant kettle lakes in the town. To afford more private well protection, a procedure was adopted to characterize the zones of contribution of private wells. The method used both direct flow measurement and groundwater elevation. In regions of high hydraulic conductivity, direct flow measurements dominated. In tighter soils, water pressure head measurement provided more information. In two residential developments, the well protection procedures were employed and contrasted with the minimal distance approach for segregating wells and septic systems. The first case involved relatively uniform conditions and constant gradients across a 20-foot thick sandy aquifer. The second case involved a concave, dipped clay basin containing a sandy outwash deposit with a convergent flow network. In both cases, consideration of flow conditions provided for greater protection to private well installations than surface minimal distance segregation. (See also W88-09477) (Geiger-PTT)
W88-09495

REGIONAL OPTIONS FOR GROUND WATER QUALITY MANAGEMENT IN RELATION TO AGRICULTURAL ACTIVITIES,
Maryland Univ., College Park. Dept. of Agricultural Engineering.
W. L. Magette, A. Shirmohammadi, B. V. Lessley, and R. A. Weismiller.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 317-327, 16 ref.

Descriptors: *Water quality management, *Water pollution prevention, *Groundwater management, *Agricultural runoff, *Management planning, Water pollution control, Public policy, Land use, Education, Irrigation practices, Economic aspects, Environmental quality.

Agricultural activities, because they involve large land areas, often are cited as a major contributor of groundwater contaminants. It appears that some degree of groundwater contamination from agricultural land use is inevitable. This is especially true in the humid eastern United States, where precipitation exceeds evapotranspiration. A comprehensive management strategy that addresses all users of groundwater can help minimize or prevent most water quality problems. In general, however, there are many more questions than answers regarding the scientific basis for groundwater management. Where agriculture is involved, any successful management scheme must include at least strong research and education components, as well as a comprehensive groundwater quality monitoring system. An effective management strategy also must include a variety of public policy instruments because there is incomplete scientific understanding of how land use affects groundwater quality. Public policy decisions can be based on common sense, scientific knowledge, and elementary economic principles. Regardless of the specific techniques used, the public - or decision makers acting on their behalf - must address the issue of what environmental quality is worth. When developing environmental policies relating to agricultural land use, a corollary issue must also be considered, i.e., the worth to American society of a reliable agricultural production system. (See also W88-09477) (Author's abstract)
W88-09496

PREPARATION OF A BEDROCK RIFS (BRIFS) ALLOWS FOR UNPREDICTABLE FLOW IN FRACTURED ROCK,
Quest Environmental Sciences, Inc., Manchester, NH.
For primary bibliographic entry see Field 2F.
W88-09500

HYDROGEOLOGIC INVESTIGATION OF WILLIAMSBURG, MASSACHUSETTS. SESSION: GLACIAL GEOLOGY/HARD ROCK,
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 2F.
W88-09503

CHEMO-HYDROGEOLOGIC TRANSPORT OF CONTAMINANTS IN GLACIAL-FLUVIAL DEPOSITS: A SITE INVESTIGATION,
Camp, Dresser and McKee, Inc., New York.
For primary bibliographic entry see Field 5B.
W88-09504

USE OF SEDIMENT PERMEABILITY VARIATIONS IN THE PERFORMANCE OF PETROLEUM RECOVERY FROM GLACIAL SEDIMENTS,
Groundwater Technology, Inc., Norwood, MA.
For primary bibliographic entry see Field 5B.
W88-09505

SITE SPECIFIC PREDICTIVE METHOD FOR REGULATING LEACHABLE PESTICIDES,
Geraghty and Miller, Inc., Tampa, FL.
For primary bibliographic entry see Field 5B.
W88-09506

DEVELOPING A STANDARDIZED SYSTEM FOR ENVIRONMENTAL ASSESSMENTS,
Shevenell Gallen and Associates, Inc., Portsmouth, NH.
For primary bibliographic entry see Field 7A.
W88-09507

REMEDIATION OF GASOLINE CONTAMINATED GROUND WATER BY INFILTRATION THROUGH SOIL,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
R. M. Allen, R. W. Gillham, and J. F. Barker.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 681-698, 9 fig, 6 tab, 16 ref.

Descriptors: *Aromatic compounds, *Groundwater pollution, *Biodegradation, *Benzenes, *Water pollution treatment, *Infiltration, Soil contamination, Fate of pollutants, Sorption, Aerobic digestion.

It was postulated that groundwater contaminated with soluble petroleum derived aromatic hydrocarbons (such as benzene, toluene, ethyl benzene and the xylene isomers, BTEX) could be remediated by natural processes when applied to soil. The processes which serve to diminish aqueous concentrations of aromatic hydrocarbons in infiltrating water are sorption, biodegradation and volatilization. Aerobic degradation of BTEX is relatively rapid and so the unsaturated soil zone could be a highly favorable environment for remediation. Remediation of groundwater by these attenuation processes in soil during infiltration was demonstrated in the field using an in situ isolated column of natural soil. Concentrations of BTEX in the contaminated source water, in the groundwater beneath the column and in the vapor phase in the soil were monitored. Gaseous oxygen concentration was also measured in the column a few times during the experiments. At the beginning of the field demonstration, physical and chemical processes governed the distribution of compounds, but after a short acclimatization period, biodegradation of the contaminants became important. The extent of BTEX attenuation in the soil depended upon the concentration applied. Complete remediation of the water occurred after an initial breakthrough, or acclimatization period, when the total BTEX concentration was 6-10 mg/l at the soil surface, and the application rate was 1.37 cm/hr. In a later experiment with about the same concentrations, after the soil had been previously exposed to BTEX, none of the contaminants persisted below 32 cm in the soil. At greater concentrations (13-28 mg/l at the soil surface), the contaminants persisted in the entire soil column for the duration of the test, however the concentration in the groundwater was substantially reduced from the applied concentration. When the concentration was reduced to 9-13 mg/l at the soil surface, complete attenuation of BTEX occurred. (See also W88-09477) (Author's abstract)
W88-09514

INNOVATIVE AQUIFER RESTORATION TECHNIQUES AT A SITE IN NORTHERN VERMONT CONTAMINATED BY GASOLINE HYDROCARBONS,
Groundwater Technology, Inc., Albany, NY.
C. J. Harper, and L. A. Williams.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 699-711, 6 fig.

Descriptors: *Groundwater pollution, *Water pollution treatment, *Activated carbon, *Fate of pollutants, *Gasoline, Water treatment, Adsorption, Degradation, Hydrocarbons, Cleanup operations, Biodegradation, Bacteria, Path of pollutants, Vermont, Water pollution control.

Subsurface contamination from lost hydrocarbons can exist in four distinct phases: phase-separated (liquid), dissolved (aqueous) phase, vapor (gaseous) phase, and adsorbed phase (adhered to the soil matrix). At a site in Northern Vermont all four phases are being remediated. Approximately 350 gallons of phase-separated gasoline have been recovered from the groundwater through a double pump recovery system. The water treatment system, consisting of an air stripper and granular activated carbon, has removed an equivalent of 40 gallons of dissolved phase gasoline from the

groundwater. Approximately 560 gallons (3,900 lbs) of gasoline have been removed from the subsurface in the vapor form using three soil venting systems. The adsorbed phase will also be remediated at this site. Most abatement programs approach the adsorbed phase by excavation or soil flushing. An Enhanced Natural Degradation (END) biostimulation program, focusing on the reduction and removal of the adsorbed organic, compounds will be undertaken. A biofeasibility study, including identification of bacterial strains of interest, their incubation rates, and their ability to degrade gasoline components, was completed. The data indicated that the biostimulation process would accelerate the clean-up of hydrocarbons in the subsurface at this site. Conceptual designs and specifications for a total END system were developed, and are currently under implementation. The additional components to be installed consist of a second reinjection gallery, a metered oxygen-addition unit, a nutrient-addition system, and associated control systems. These components will be linked into the existing pumping and treatment network to comprise a total abatement program. Hydrogen peroxide will be added with nitrogen and phosphorus to treated groundwater. This solution will be reinjected into the subsurface to stimulate growth of hydrocarbon-utilizing bacteria. The END program is expected to accelerate cleanup of the site from an estimated 10 years using a conventional pump-and-treat approach, to within 1.5 years using the comprehensive pump-and-treat plus bioreclamation approach. (See also W88-09477) (Author's abstract)
W88-09515

EFFECTIVE USE OF A LATERALLY EXTENDED WELL HYDROCARBON RECOVERY IN LOW PERMEABILITY SEDIMENTS ALONG A RIVER,
Johnson Co., Inc., Montpelier, VT.
C. T. Stone.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 713-732, 13 fig, 2 tab, 5 ref.

Descriptors: *Fluvial sediments, *Oil spills, *Oil recovery, *Cleanup operations, *Water pollution treatment, *Groundwater pollution, Aquifers, Test wells, Monitoring, Hydrocarbons, Vermont.

In 1972, the majority of a 6,000 gallon fuel oil delivery overflowed at a weighing scale manufacturing plant in northern Vermont. This spill occurred within 75 feet of a river. Thirteen years later, reports of gross oil seepage along the river bank led to a remedial investigation and cleanup effort. The site stratigraphy is as follows: zero feet to five feet medium sand, five feet to fourteen feet fine sandy silt, fourteen feet to twenty five feet fine to coarse sand. Monitoring wells revealed that the majority of the free NAPL (non-aqueous phase liquid) resided in the silty layer and ranged in thickness from one foot to four feet. In one area NAPL extended into the coarse sands below the silt layer. The proximity of the area of contamination to the river and the low permeability of the sediments made a single well recovery system problematic because the zone of influence would be limited by the constant head boundary of the river and low hydraulic conductivity. In place of multiple wells, which would be effective under these conditions, a laterally extended well was proposed. This well was constructed in September 1986 by excavating a seventy foot trench, thirteen feet to seventeen feet deep parallel to the river. The lower five to eight feet of the trench were backfilled with crushed stone and a single recovery sump placed at the mid point of the trench. Since November 12, 1986, water table depression has been accomplished with pumping rates of four to five gallons per minute. In the first month of operation gross oil seepage to the river was halted. After seven months of operation the system has recovered 2,300 gallons of fuel oil and no further oil seepage has been observed in the area influenced by this system. (See also W88-09477) (Author's abstract)
W88-09516

USE AND PLACEMENT OF GROUTING AND SEALING MATERIALS,
Vermont Agency of Natural Resources, North Waterbury, VT.
J. W. Ashley.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 735-748, 2 tab, 13 ref.

Descriptors: *Grouting, *Sealants, *Well sealing, *Wells, *Water wells, *Well construction, *Cements, Bentonite, Leakage, Drilling.

Proper sealing or grouting of the annular space of a well is critical to the use and performance of the well. Proper sealing or grouting seeks to restore the borehole to its original condition. Improper sealing or grouting can result in cross contamination, aquifer damage, loss of well performance and potential damage to the well itself. The failure of many wells can be traced to an inadequate sealing or grouting program. Both of the two principal grouting materials, cement and bentonite, have real, perceived and administrative deficiencies. These problems may be further complicated by the drilling method and well construction proposed and the hydrogeologic environment in which the well will be located. Except for limited or special conditions, native materials cannot be adequately placed or are inappropriate to serve as annular space sealing materials. The selection, modification and use of commercial grouting and natural sealing materials are described along with how the anticipated hydrogeologic environment and proposed well construction should influence drilling methods and grout use and placement. Some continuing problems and controversies are identified along with some current practices. (See also) W88-09477) (Author's abstract)
W88-09517

POTENTIAL FOR FISHERIES REHABILITATION IN THE HAMILTON HARBOUR-COOTES PARADISE ECOSYSTEM OF LAKE ONTARIO,
Toronto Univ. (Ontario). Dept. of Zoology.
J. A. Holmes.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 131-141, 1988. 2 fig, 3 tab, 45 ref.

Descriptors: *Lake restoration, *Lake fisheries, *Water pollution control, *Lake rehabilitation, *Lake Ontario, *Fisheries, *Rehabilitation, Fish management, Great Lakes, Hamilton Harbor, Aquatic habitats, Habitats, Cootes Paradise, Fish populations, Oxygen depletion, Sedimentation, Eutrophication, Wetlands, Marshes, Nutrients.

Historical data were used to assess the rehabilitation potential of western Lake Ontario fisheries. The Hamilton Harbor ecosystem at the western end of Lake Ontario is seriously degraded. The impediments to rehabilitation are habitat losses, hypolimnetic anoxia, sediments contaminated with heavy metals and toxic organic chemicals, excess nutrients, and sediment inputs. Rehabilitation should focus on the warm water fish assemblage because the cold water fishery has little potential for restoration in the near future. Carroll's Point has the best potential for rehabilitation, the south shore has no potential, and other points fall between the two extremes. Problems at Cootes Paradise, a large wetland which has moderate potential for rehabilitation, include sediment inputs from Spencer Creek, nutrients from the Dundas sewage treatment plant, and a large carp population. (Cassar-PTT)
W88-09546

USE OF PREDICTION TO ASSESS MACROINVERTEBRATE RESPONSE TO RIVER REGULATION,
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 2H.
W88-09621

DILUTION BIOASSAYS: THEIR APPLICATION TO ASSESSMENTS OF NUTRIENT LIMITATION IN HYPEREUTROPHIC WATERS,
North Carolina Univ., Morehead City. Inst. of Marine Sciences.
For primary bibliographic entry see Field 7B.
W88-09634

NUTRIENT RESPONSES TO THE LIMING OF LAKE GARDSJON,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
O. Broberg.
Hydrobiologia HYDRB8, Vol. 150, No. 1, p 11-24, May 30, 1987. 6 fig, 4 tab, 40 ref.

Descriptors: *Water pollution treatment, *Limnology, *Acid rain, *Lake restoration, *Lime, *Nutrients, *Lakes, *Chemical analysis, *Acidic water, Sweden, Nitrogen compounds, Nitrates, Ammonium, Particulate matter, Carbon, Nitrogen, Dissolved solids, Phosphorus.

The acidified Lake Gardsjon and Lake Stora Hastevatten the reference lake have been monitored since 1979 and 1980 respectively. The lakes are situated in SW Sweden, in an area severely affected by acid deposition. Lake Gardsjon was limed in spring 1982. This paper analyzes changes in nutrient concentrations upon liming of Lake Gardsjon. The liming of Lake Gardsjon was followed by a slight increase in ammonium, nitrate, and dissolved organic nitrogen concentrations. A drastic decrease occurred in particulate nitrogen and particulate carbon, whereas dissolved organic carbon increased. Total phosphorus and particulate phosphorus concentrations were similar to pre-limed conditions. The long-term decrease in phosphorus concentration, exhibited by the reference lake, was not identified in Lake Gardsjon after liming, but total phosphorus concentration was still less than half compared to Lake Gardsjon in the early 1970's. Additional measures such as phosphorus fertilization, should in certain cases be considered in addition to liming if the goal is to restore lakes to their pre-acidic conditions. (Author's abstract)
W88-09684

EFFECTS OF SHELLSAND ON WATER QUALITY AND MATURE BROWN TROUT (EFFEKT AV SKJELLSAND PA VANNKVALITET OG KJONNSMODEN AURE),
Fylkesmannen i Vesfold, Miljovernavd, Toensberg (Norway).
R. Andersen, O. Haraldstad, I. P. Muniz, and T. Sullivan.
Fauna FUNAAO, Vol. 40, No. 4, p 150-159, 1987. 8 fig, 1 tab, 30 ref.

Descriptors: *Lake restoration, *Shellsand drums, *Trout, *Brown trout, *Water quality, *Neutralization, *Acid streams, *Lime, Coastal streams, Calcium, Aluminum, Hydrogen ion concentration, Spawning, Water pollution treatment, Norway.

In Norway there has been much controversy about the neutralization effects of shellsand drums. A drum that has been in continuous operation since April 1984. It has worked well, even in cold periods with the temperature down to minus 20 C. However, the shellsand drum was only partly effective with a minimum of 23% of the particles dissolving. The shellsand drum elevated calcium and alkalinity, but during periods of high discharge there was a subsequent drop in pH, a sharp increase in labile monomeric aluminum and a decrease in calcium. Male and female spawners and female postspawners of brown trout were exposed to the limed stream-water. Neither pronounced physiological stress nor mortality was observed in any of the fish groups. The authors conclude that in small coastal, acidic streams a combination of shellsand drum and mixing of shellsand into the spawning substrate may significantly improve the recruitment of brown trout. (Author's abstract)
W88-09699

APPLYING THE USGS MASS-TRANSPORT MODEL (MOC) TO REMEDIAL ACTIONS BY RECOVERY WELLS,
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
For primary bibliographic entry see Field 2F.
W88-09781

MACROZOOBENTHOS OF STRUMA RIVER: AN EXAMPLE OF A RECOVERED COMMUNITY AFTER THE ELIMINATION OF A HEAVY INDUSTRIAL IMPACT WITH SUSPENDED MATERIALS,
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
Y. Uzunov, and S. Kovachev.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 1/2, p 169-196, June 1987. 9 fig, 4 tab, 38 ref.

Descriptors: *Water pollution prevention, *Dam effects, *Struma River, *Bulgaria, *Macroinvertebrates, *Species composition, Suspended solids, Limnology, Ecological effects, Suspended sediments, Population dynamics, Lobosh Dam, Rivers.

The ecological state, the composition and structure of the benthic invertebrate communities in Struma, the biggest river in southwest Bulgaria, are discussed as they are now and retrospectively for a period of almost 10 years, after the elimination of a heavy inert loading with suspended materials. Since 1975 the Lobosh Dam has effectively removed both the large quantities of suspensions and the accompanying heavy organic pollution by the Pernik urban-industrial agglomeration. The process of recovery and stabilization of the hydrochemical and saprobiological state of the river was traced. The stages of formation of an adequate zoobenthos in composition and structure zoobenthos are described. There was a general trend of diversification of the invertebrate benthic fauna, which took place under the conditions of competition for new ecological niches and species specialization within the community. The role of the tributaries was traced. The physical nature of such an impact and its independence from the saprobic processes is stressed. Its specifically destructive effects on the macrozoobenthos are shown. The present ecological state of Struma is characterized as optimal and balanced along the whole 210 km stretch after the Lobosh Dam. The river has a powerful self purification potential and successfully utilizes the local organic impacts without changing its stable Beta-mesosaprobity level. The structural parameters of the macrozoobenthos (species diversity, evenness and dominance) correspond to the definition of a mature community. (Author's abstract)
W88-09886

CYCLOPOID COPEPODS IN MARGINAL HABITATS: ABIOTIC CONTROL OF POPULATION DENSITIES IN ANTHROPOGENIC ACIDIC LAKES,
Oslo Univ. (Norway). Dept. of Biology.
S. Sandoy, and J. P. Nilssen.
Archiv fuer Hydrobiologie, Supplement Vol. 76, AHBSA8, No. 3, p 236-255, July 1987. 7 fig, 3 tab, 52 ref.

Descriptors: *Acid rain effects, *Liming, *Acid lakes, *Copepods, *Water pollution effects, *Lake restoration, *Reproduction, Population dynamics, Food habits, Hydrogen ion concentration, Lakes, Norway, Acidic water, Fertility, Plankton.

The cyclopoid copepods Mesocyclops leuckarti and Cyclops scutifer were studied during four years in two acidic lakes in southern Norway. One of the lakes was limed, resulting in increased pH from 4.7 to 7.5. Liming had a positive effect on both cyclopoid species. Population density increased fifteenfold compared to pre-liming conditions while densities in the unlimed lake showed small differences between years. Liming and decreased acidity resulted in elevated egg production and increased abundance. Natural decrease of acidity in the control lake during one of the years resulted in similar effects on the fecundity and population growth of the cyclopoids. The low abundances of cyclopoid copepods usually found in acid lakes may therefore be caused by disturbances in the egg production process, resulting in reduced fecundity. Neither changed food availability nor predation pressure could explain the observed variations in population density. The most important factors causing the changes were abiotic, connected with liming, while biotic factors played a minor role. Tolerance limits of cyclopoids to low pH and effects on the pelagic plankton community by decreasing abundance and total disappearance of cyclopoid copepods are discussed. (Author's abstract)
W88-09889

ASSESSMENT AND CONTROL OF RISKS FROM LEGIONNAIRES DISEASE,
For primary bibliographic entry see Field 5F.
W88-09962

ENHANCED REPRODUCTIVE POTENTIAL OF NEOCHETINA BRUCHI HOSTACHE FED ON WATER HYACINTH PLANTS FROM POLLUTED WATER BODIES,
Regional Research Lab., Hyderabad (India).
For primary bibliographic entry see Field 5C.
W88-09970

MODELING DISTRIBUTION-SYSTEM WATER QUALITY: DYNAMIC APPROACH,
Grayman (Walter M.), Concinnati, OH.
For primary bibliographic entry see Field 5F.
W88-09982

BIORESTORATION OF AQUIFERS CONTAMINATED WITH ORGANIC COMPOUNDS,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
M. D. Lee, J. M. Thomas, R. C. Borden, P. B. Bedient, and C. H. Ward.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 18, No. 1, p 29-89, 1988. 2 fig, 9 tab, 272 ref.

Descriptors: *Rehabilitation, *Cleanup operations, *Water quality control, *Groundwater pollution, *Aquifers, *Biological treatment, *Water pollution treatment, *Biorestoration, Drinking water, Industrial water, Agricultural water, Groundwater quality.

Organic compounds can contaminate aquifers by inadvertent spills, improper waste disposal, and agricultural practices. This paper reviews in situ biostimulation techniques for groundwater remediation. Of the available biological aquifer remediation techniques, the most effective demonstrated methods are enhancement of the native microbial population and withdrawal and treatment by various wastewater treatment processes. In situ biorestoration compares favorably with other common remedial actions such as excavation and withdrawal and treatment by carbon absorption or air stripping, and, when successful, generally costs less than physical or chemical remediation techniques. When applicable, biological treatment may offer the advantage of partial or complete destruction of the contaminants rather than simply transferring the pollution to another phase of the environment. (Roseman-PTT)
W88-09988

EFFECTS OF PHOSPHORUS REMOVAL ON THE MAXIMAL ALGAL GROWTH IN BIOASSAY EXPERIMENTS WITH WATER FROM FOUR DUTCH LAKES,
Hoogheemraadschap van Rijnland, Leiden (Netherlands).
J. van der Does, and S. P. Klapwijk.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 72, No. 1, p 27-39, 1987. 13 fig, 16 ref.

Descriptors: *Limiting nutrients, *Nutrient removal, *Water quality management, *Eutrophication, *Algal growth, *Lakes, *Phosphorus removal, Rijnland, The Netherlands, Biomass, Algae, Wastewater treatment, Bioassay, Phytoplankton.

This paper reports the effect of phosphorus removal at three sewage wastewater treatment plants on the state of eutrophication of four shallow lakes in the southeastern part of the Rijnland Waterboard area during the years 1980-1982. With chemical analyses and bioassay experiments using the natural phytoplankton population no significant lowering could be detected of, respectively, the phosphate concentration and the maximal algal growth potential. All lakes proved to be principally nitrogen limited except the Reeuwijk Lakes, which showed clearly, after a primary nitrogen limitation, a secondary phosphorus limitation. Therefore, the main attention with respect to phosphorus reduction should be concentrated on the Reeuwijk Lakes in the first place. For the other lakes in the investigated area phosphorus removal will, when it is the only measure taken, presumably not lead at short notice to a decrease of the algal biomass. (Author's abstract)
W88-09989

EFFECTS OF TILLAGE SYSTEM, CROP RESIDUE LEVEL, AND FERTILIZER APPLICATION TECHNIQUE ON LOSSES OF PHOSPHORUS AND PESTICIDES FROM AGRICULTURAL LANDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W88-10025

ASSESSMENT AND COMPILATION OF GROUNDWATER QUALITY DATA FOR MISSISSIPPI,
Mississippi State Univ., State College. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W88-10027

ECONOMIC AND PREDICTIVE RELIABILITY IMPLICATIONS OF STORMWATER DESIGN METHODOLOGIES,
Florida Univ., Gainesville. Water Resources Research Center.
For primary bibliographic entry see Field 6A.
W88-10030

UNDERGROUND STORAGE TANK DISPOSAL: ALTERNATIVES, ECONOMICS, AND ENVIRONMENTAL COSTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5E.
W88-10036

FINANCIAL RESPONSIBILITY PROVISIONS FOR UNDERGROUND TANKS IN VIRGINIA,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
P. S. Thompson, W. D. Conn, and L. L. Geyer.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-186127/AS. Price codes: A03 in paper copy; A01 in microfiche. Virginia Water Resources Research Center, Blacksburg, Bulletin 161, February 1988. 39 p, 9 ref.

Descriptors: *Virginia, *Underground storage tanks, *Financial responsibility, *Petroleum products, Insurance, Leak prevention, State legislation, Water quality standards, Resource Conservation and Recovery Act.

Under the provisions of recent federal and state legislation, the owners and operators of underground storage tanks containing petroleum products are required to maintain evidence of financial responsibility. The requirements as they presently stand, different ways of meeting them, and associated issues were examined. The regulated community is described as well as proposed financial responsibility regulations under RCRA Title 1, their relevance to the situation in Virginia and to any state regulatory initiatives, and a suggested set

of criteria for judging these initiatives. The next section describes allowable financial responsibility assurance mechanisms, and reviews the advantages and disadvantages associated with each. A critique follows of financial responsibility legislation recently enacted in Virginia. Conclusions and recommendations are intended to assist state decision-makers in designing and implementing an effective set of financial responsibility regulations for underground storage tanks. (USGS)
W88-10037

ECONOMIC AND INSTITUTIONAL ASPECTS OF RISK AND LIABILITY IN THE CONTROL OF GROUNDWATER POLLUTION,
Wisconsin Univ., Madison. Dept. of Agricultural Economics.
T. D. Rojas, and K. Segerson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-155940/AS. Price codes: A03 in paper copy; A01 in microfiche. Wisconsin Water Resources Center, Madison, Technical Report WIS WRC 87-03, 1987. 40 p, 2 fig, 1 tab, 19 ref. Contract 14-08-0001-G1053. Project USGS G-1053-06.

Descriptors: *Cost analysis, *Groundwater pollution, *Liability, *Regulation, *Risks, Economic aspects, Groundwater, Policy making, Public policy, Water pollution control, Legal aspects, Landfills, Wisconsin, Onalaska, Sheboygan County.

Two alternatives means of controlling negative externalities (pollution), namely the use of ex ante regulation and the use of ex post liability, were compared. Alternative forms of liability, in particular strict liability and negligence, are discussed. The different approaches are first compared using theoretical models of externalities to determine when one might be theoretically preferred to another. The practical limitations of each as a means of controlling pollution are also discussed. The results of the theoretical analysis suggest that, because no single alternative is a perfect control mechanism, the joint use of regulation and some form of liability is perhaps best. The results were used as background information in an analysis of two case studies of groundwater pollution. The first is contamination from the Kohler Company landfill in Sheboygan County, Wisconsin. The second is contamination from a municipally owned landfill in Onalaska, Wisconsin. It was found that the existence of regulations did not prevent contamination at either site and some form of liability was necessary to internalize pollution costs. However, the regulations in existence served a useful purpose, complementary to that of liability. Pursuant to those regulations the regulatory authority had collected information to document the causes and extent of contamination. The availability of this information greatly increased the prospects for successful suits under the liability approach. Thus, one significant benefit of regulation may be information generation that increases the effectiveness of liability rules. (WWRC)
W88-10043

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

PREDICTING THE TROPHIC STATUS OF RESERVOIRS IN SEMI-ARID REGIONS,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5C.
W88-09051

NECESSARY INVOLVEMENT AND RESPONSIBILITY OF SEPARATE ENTITIES IN PLANNING AND PERFORMANCE OF AQUIFER RESTORATION,
For primary bibliographic entry see Field 6E.
W88-09130

RATIONAL APPROACH TO THE DESIGN OF GROUND-WATER MONITORING SYSTEMS, USING BAYESIAN DECISION THEORY,
Holzmacher, McLendon and Murrell, Melville, NY.
For primary bibliographic entry see Field 7A.
W88-09153

ALTERNATIVE ENDPOINTS FOR RECLAMATION,
Liverpool Univ. (England). Dept. of Botany.
A. D. Bradshaw.
IN: Rehabilitating Damaged Ecosystems. Volume II. CRC Press, Inc., Boca Raton, Florida. 1988. p 69-85, 3 fig, 2 tab, 33 ref.

Descriptors: *Land reclamation, *Ecosystems, *Management planning, *Alternatives planning, *Cleanup operations, Coal mining, England, Systems analysis, Social aspects, Mine wastes, Project planning.

Degraded ecosystems are found in all parts of the world, wherever human populations occur, in tundra, steppe, arable land, or forest. The immense diversity of environments makes it very obvious that the endpoints for restoration are immensely varied, even if the aim is merely to replace the ecosystem that existed before the degradation took place. If it is assumed that precise restoration is not required but just some sort of reclamation, that there are many human cultures, and that each culture may have many different expectations for any given area of degraded land, the endpoints for reclamation become remarkably diverse. What is necessary is a systematic approach to each area of wasteland. In this the first step is that the qualities of the site and the needs of the region and its people must be interrelated. From this can be developed a possible endpoint. At this stage the details of the treatments that will be necessary can be determined and costed, and matched to available funds. Here will be the stage where negative or positive feedback can occur. The detailed appraisal may confirm the original choice of endpoint; but equally it may suggest that modifications or a complete alternative would be better. This process may need to be repeated before the endpoint is finally established. This discussion takes a view based on experience of reclamation of new mining and already existing waste land in Britain, with only occasional samples from elsewhere. In Britain, a very considerable government funded program has been in existence ever since the Aberfan disaster in 1968, when a colliery soil heap slid down the side of a mountain in Wales and killed 116 children in school. A limited study of possible endpoints in just one region and one culture can provide a better framework for understanding the problem than would a wider examination. (See also W88-09457) (Lantz-PTT)
W88-09459

WATER QUALITY-BASED CONTROLS AND ECOSYSTEM RECOVERY,
Environmental Protection Agency, Washington, DC. Monitoring and Data Support Div.
For primary bibliographic entry see Field 5G.
W88-09460

GROUNDWATER MANAGEMENT ISSUES IN THE ATLANTIC PROVINCES,
Environmental Protection Service, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 4B.
W88-09480

RISK DRIVEN SITE INVESTIGATIONS: TWO CASE STUDIES OF LEAKING UNDERGROUND STORAGE TANKS,
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5G.
W88-09488

WATER RESOURCES ASSESSMENT: A SPATIAL EQUILIBRIUM APPROACH,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 7A.
W88-09538

CADD - GENERATED WATER SYSTEM ATLAS OFFERS FLEXIBILITY,
For primary bibliographic entry see Field 6B.
W88-09659

INSTREAM FLOW STUDIES IN PERSPECTIVE,
Tulsa Univ., OK. Faculty of Biological Science.
For primary bibliographic entry see Field 6D.
W88-09720

MONITORING THE IMPACT OF DAMS ON THE DOWNSTREAM PHYSICAL ENVIRONMENT IN THE TROPICS,
Bayero Univ., Kano (Nigeria). Dept. of Geography.
For primary bibliographic entry see Field 6G.
W88-09726

ENVIRONMENT ORIENTED MANAGEMENT SYSTEM OF RIVER BASIN: CASE STUDY IN YAHAGI RIVER BASIN, CENTRAL JAPAN,
Nagoya Univ. (Japan). Dept. of Earth Sciences.
H. Fukui.
Journal of Earth Science JEASAD, Vol. 33, p 49-80, December 1985. 21 fig, 4 tab, 12 ref.

Descriptors: *River basins, *Yahagi River, *Management planning, *Water resources development, Social aspects, Political aspects, Economic aspects, Legal aspects, Regional analysis, Watersheds, Statistical, Hydrology, Geohydrology, Rivers, Japan, Multivariate analysis, Model studies.

The idea of managing environmental resources and concrete methods of management should be based on methods mean that the local residents have devised over a long period of time, considering the biogeophysical, socioeconomic, cultural and historical characteristics of the respective districts. Generally, biogeophysical environments and socioeconomic activities depend on a utilization of river water in Japan. As a case study, planning was carried out in the Yahagi River Basin, which is designated by the National Land Agency as a model region for the purposes of surveys of River Basin Integrated Settlements. The following three approaches are employed: (1) identification of regional characteristics based on objective data (a classification of small-watersheds using multivariate analysis); (2) identification of the environmental carrying capacity based on watershed structure (input-output analysis of water quantity and quality); and (3) clarification of a future vision of the regional environment (public participation gaming to structuralize public needs). It is expected that these management information and environmental data obtained by the above approaches contribute to an environmentally sound development of the districts, used effectively in formulating various programs of the environment. Possible strategies are proposed for development programs of water system in Yahagi River Basin. (Author's abstract)
W88-09949

WATER DISTRIBUTION RELIABILITY: ANALYTICAL METHODS,
Massachusetts Inst. of Tech., Cambridge. Operations Research Center.
For primary bibliographic entry see Field 5F.
W88-09980

WATER DISTRIBUTION RELIABILITY: SIMULATION METHODS,
Massachusetts Inst. of Tech., Cambridge. Operations Research Center.
For primary bibliographic entry see Field 5F.
W88-09981

COMPUTER-AIDED APPROACH TO AGRICULTURAL FLOOD HAZARD MANAGEMENT IN FLORIDA.

Florida Univ., Gainesville. Dept. of Agricultural Engineering.
L. B. Baldwin, K. L. Campbell, A. B. Bottcher, J. C. Capece, and R. Burleson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164082/AS. Price codes: A06 in paper copy; A01 in microfiche. Florida Water Resources Research Center, Gainesville, Publication No. 99, 1987. 112 p, 20 fig, 9 tab, 89 ref, 3 append. Contract No. 14-08-0001-G1218. Project No. USGS G1218-04.

Descriptors: *Runoff quality control, *Florida, *Stormwater runoff, *Nutrient attenuation, Flood control, Engineering design models, Agriculture, Model studies, Stormwater management, Flood hazard, Soil water, Evapotranspiration, Agricultural runoff.

In order to evaluate crop-evapotranspiration (ET) relations, the CREAMS-WT hydrologic model was used to consider the effects of vegetation in its determination of ET. This is accomplished by first estimating potential evapotranspiration (PET) with a modified Penman equation. Leaf-area-index (LAI), radiation, and available soil moisture determine actual ET from PET. A simple plant root growth model is used to partition the ET extractions of soil water among the different soil layers. In order to analyze agricultural stormwater systems, a model was developed for this purpose and referred to as CRWT-HYDRO. A routine to generate runoff hydrographs was incorporated and linked to a multibasin reservoir-channel routing program. A computer model was developed to analyze nutrient capture or loss in various types of impoundments in a water management system. In describing this nutrient attenuation model, considerable detail as to various rate coefficients is presented. (USGS)
W88-10015

MULTIOBJECTIVE RESERVOIR OPERATION USING FORECASTS OF WATER SUPPLY AND WATER USE,
Interstate Commission on the Potomac River Basin, Rockville, MD.
J. A. Smith, S. S. Schwartz, J. J. Boland, and J. B. Whitcomb.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-161468/AS. Price codes: A09 in paper copy; A01 in microfiche. Report, November 1987. 193 p, 60 fig, 4 tab, 127 ref. Contract No. USGS 14-08-0001-G1145.

Descriptors: *Forecasting, *Reservoir operations, *Multiobjective programming, *Water supply, *Water use, *Flood control, *Statistical models, *Potomac River Basin, Washington D.C., Metropolitan area, Optimization, Parametric operating rules.

Operating rules for water supply and flood control were developed. Operating rules for water supply incorporate forecasts of both water supply and water use. The water use forecast system that was developed is based on a time series model of water use. The model is termed a conditional autoregressive model and can be viewed as an autoregressive model with random mean. Nonparametric techniques were developed for water supply forecasting. Operating rules for both water supply and flood control are 'parametric operating rules.' Heuristically, a parametric operating rule is one that specifies releases from a reservoir system at time t as a function of forecasts based on data collected up until time t and a finite number of real-valued parameters. Parametric operating rules for flood control operation characterize the flood hydrograph by the delay and attenuation of the flood peak. The stochastic sequential nature of real-time flood control operation is represented as a two-stage recourse problem. The combination of stochastic optimization and multiobjective programming is a unique approach to developing operating rules. Procedures were applied to reservoir management problems in the Potomac River Basin. (USGS)
W88-10018

MODEL FOR OPTIMIZATION OF SOCIO-ECONOMIC FISHERY VALUES ON THE RIO GRANDE IN NEW MEXICO,
New Mexico State Univ., Las Cruces. Dept. of Fishery and Wildlife Sciences.
For primary bibliographic entry see Field 6D.
W88-10022

EFFECTIVENESS OF BMPS FOR STORMWATER MANAGEMENT IN URBANIZED WATERSHEDS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W88-10029

ECONOMIC AND PREDICTIVE RELIABILITY IMPLICATIONS OF STORMWATER DESIGN METHODOLOGIES,
Florida Univ., Gainesville. Water Resources Research Center.
B. A. Cunningham, and W. C. Huber.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-189378. Price codes: A08 in paper copy; A01 in microfiche. Publication No. 98, 1987. 146 p, 65 tab, 62 fig. Contract No. 14-08-0001-G1218. State Project No. FL-02, USGS Project No. G1218-02.

Descriptors: *Stormwater design, *Model studies, *Design criteria, *Storm runoff, *Design storms, *Simulation analysis, Flood control, Runoff, Quality control, Engineering, Mathematical models, Cost-Benefit analysis, Florida, Prediction, Storm water, Management model.

Seven alternative analytical methodologies for drainage design and hydrologic analyses were compared: rational method, synthetic unit hydrograph method, SCS peak discharge method, SCS tabular hydrograph method, regression equations, modeling with synthetic design storms, continuous simulation with historic storms, and USGS flood frequency methods. Modeling was accomplished using the EPA Storm Water Management Model (SWMM). The SWMM model was calibrated on each catchment and then run continuously for the number of years of hourly data available from the National Weather Service (22-38 years). The SWMM Statistics Block was then used to rank storm runoff volumes and storm runoff peaks in order to perform a frequency analysis on these two parameters. Results were compared to the conventional methods listed above and current USGS urban flood frequency results. Simulated real events tended to have higher peaks than did the USGS estimates, and the highest simulated peak from the long-term record was higher than the 25-year SCS peak for four out of the five catchments. These results generally contradict conventional wisdom which assumes that synthetic design storms will give higher (more conservative) peak flows than will historic flows. Man-hours for design efforts are greatest for the continuous simulation approach and least for the rational method. Construction costs vary widely, depending on peak flows predicted by each method and resulting pipe sizes. (Huber-U. FL)
W88-10030

ANALYSIS OF WATER QUALITY MODEL UNCERTAINTY USING A BAYESIAN MONTE CARLO METHOD,
Michigan Univ., Ann Arbor. Dept. of Environmental Health.
D. W. Dilks.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8712097. Ph.D Dissertation, 1987. 174 p, 35 fig, 3 tab, 51 ref.

Descriptors: *Water quality, *Model studies, *Monte Carlo method, *Error analysis, Mathematical analysis, Phosphorus, Dissolved oxygen, Statistical analysis, Quantitative analysis.

Techniques of quantifying errors in water quality models were improved using Bayesian Monte Carlo method. The method was applied to a total phosphorus model of Green Bay, Lake Michigan and to a dissolved oxygen model for combined sewer overflows on the Grand River in Michigan. Four other studies were also performed using these models. Bayesian Monte Carlo provided posterior information on the frequency distribution for dispersion and phosphorus settling velocity for the Green Bay model, implying that the value taken by these parameters significantly affects the ability of the model to simulate the observed data. Bayesian Monte Carlo also provides significant information on the frequency distribution for all uncertain parameters of the Grand River dissolved oxygen model. Consideration of the ability of each parameter that was set to simulate observed data reduced the uncertainty in predicted minimum dissolved oxygen by a factor of three. The relationships between model parameters play a far greater role in the results of Monte Carlo analysis than was previously believed. Bayesian Monte Carlo provides a method for quantitatively determining the impact of increased or reduced error variance in the observed field data on uncertainty projections for unmeasured parameters. (Cremmins-AEPCO)
W88-10081

METERING UTILITY SERVICES: THEORY AND WATER SUPPLY APPLICATIONS,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6C.
W88-10084

USE OF STOCHASTIC DYNAMIC PROGRAMMING FOR OPTIMUM RESERVOIR MANAGEMENT,
California Univ., Los Angeles. School of Engineering and Applied Science.
T. Trezos.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8614123. Ph.D Dissertation, 1986. 116 p, 12 fig, 1 tab, 40 ref, 2 append.

Descriptors: *Dynamic programming, *Hydroelectric power, *Reservoir operation, *Water resources development, Model studies, Stochastic hydrology, Optimum development plans, Linear programming, Algorithms, Computer programs.

Stochastic dynamic programming is used to study ways to increase output from hydroelectric systems within physical and operational limitations. Emphasis is placed on the uncertainty of the forecast, time decomposition, and the statistical characteristics of the system response when aggregated information is used. The developed methodology is applicable for constrained stochastic systems with quadratic objective function and linear dynamics. The developed model may become useful in the planning of operating strategies over a specified period, water resources development, facilities planning, and determining maintenance schedules for hydroelectric units. Avoiding discretization of the state and control variables in a dynamic programming formulation allows the model to be applicable to large-scale systems. (Cremmins-AEPCO)
W88-10086

SEARCH FOR PURITY: A RETROSPECTIVE POLICY ANALYSIS OF THE DECISION TO CHLORINATE CINCINNATI'S PUBLIC WATER SUPPLY, 1890 - 1920,
Cincinnati Univ., OH. Div. of Graduate Studies and Research.
For primary bibliographic entry see Field 5F.
W88-10087

6B. Evaluation Process

ASSESSMENT OF AQUATIC EFFECTS DUE TO ACID DEPOSITION,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5C.
W88-08961

PLANNING FOR AN INDIVIDUAL WATER SYSTEM.
For primary bibliographic entry see Field 5F.
W88-08973

PACIFIC NORTHWEST RIVERS STUDY ASSESSMENT GUIDELINES: WASHINGTON STATE.
Washington State Energy Office, Olympia.
For primary bibliographic entry see Field 6G.
W88-09032

STATUS OF THE NATION'S WATER QUALITY INFORMATION ACTIVITIES.
Geological Survey, Reston, VA. Office of Water Data Coordination.
For primary bibliographic entry see Field 7C.
W88-09039

GROUND-WATER DATA REQUIREMENTS ANALYSIS FOR THE ENVIRONMENTAL PROTECTION AGENCY.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 7A.
W88-09045

RISK ASSESSMENT AT HAZARDOUS WASTE SITES.
For primary bibliographic entry see Field 5E.
W88-09056

INDUSTRY'S GUIDELINES FOR RISK ASSESSMENT,
Shell Oil Co., Houston, TX.
For primary bibliographic entry see Field 5E.
W88-09060

METHODOLOGY FOR ASSESSING UNCONTROLLED SITE PROBLEMS AT THE COUNTY LEVEL,
State Univ. of New York Coll. at Geneseo. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5E.
W88-09061

CURRENTLY AVAILABLE GEOPHYSICAL METHODS FOR USE IN HAZARDOUS WASTE SITE INVESTIGATIONS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W88-09063

LIMITATIONS IN IMPLEMENTING AQUIFER RECLAMATION SCHEMES,
Schmidt (Kenneth D.), Fresno, CA.
For primary bibliographic entry see Field 5G.
W88-09142

COMPREHENSIVE AQUIFER EVALUATION AND LAND-USE PLANNING FOR AQUIFER RESTORATION AND PROTECTION IN ACTON, MASSACHUSETTS,
R. M. Crystal, and R. W. Heeley.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 175-186, 5 fig, 5 tab, 8 ref.

Descriptors: *Water pollution treatment, *Water pollution control, *Aquifer management, *Groundwater pollution, *Regulations, *Potable water, *Public waters, *Land use planning, Evaluations, Monitoring, Analytical models, Protections, Wastewater analysis, Groundwater movement, Water quality management.

Aquifer protection has recently become a high priority in Acton, Massachusetts, because of the town's total dependence on ground water for drinking water supplies, rapid growth rate, intent to refrain from sewer construction and serious ground-water pollution problems. This paper describes Acton's comprehensive aquifer evaluation and land-use planning program. The program demonstrated several key principles: (1) By identifying areas for water-supply protection and protecting them through appropriate land-use regulations, ground-water pollution can be readily avoided; (2) Where a variety of wastewater discharges exist, careful monitoring of water quality and groundwater flow directions is often required before new well sites are developed; (3) in unsewered areas like Acton, a combination of monitoring and appropriate analytic modeling techniques can provide the technical basis for zoning density controls and performance standards on wastewater discharge to prevent excessive nitrate levels in public and private wells. The program in Acton included long-term monitoring, delineation of three different protection areas including a well buffer area, recharge protection area, and aquifer protection area, and analytic modeling assessments of current and saturation development ground-water nitrate levels. Future saturation nitrate levels with existing zoning predicted by the model were substantially higher, ranging from 5.7 mg/L to 13.6 mg/L. Since the federal drinking water standard for nitrate is 10 mg/L, these results led to proposed zoning changes, changing two currently-zoned industrial areas to prohibit such use. (See also W88-09129) (Friedmann-PTT)
W88-09150

DEVELOPMENT AND IMPLEMENTATION OF GUIDELINES FOR DISPERSANT USE: REGIONAL RESPONSE TEAMS,
National Ocean Service, Seattle, WA. Ocean Assessments Div.
For primary bibliographic entry see Field 5G.
W88-09207

OIL SPILL DISPERSANTS: DOES SOUTH AFRICA HAVE AN ALTERNATIVE,
Sea Fisheries Research Inst., Cape Town (South Africa).
For primary bibliographic entry see Field 5G.
W88-09209

TOWARD A COST-BENEFIT ASSESSMENT OF GROUND WATER QUALITY REGULATION,
Salt River Project, Phoenix, AZ.
For primary bibliographic entry see Field 5G.
W88-09265

CADD - GENERATED WATER SYSTEM ATLAS OFFERS FLEXIBILITY,
J. E. Potts.
Public Works PUWOAH, Vol. 119, No. 6, p 81-88, June 1988.

Descriptors: *Computer-aided design and drafting, *Computers, *Maps, *Water treatment facilities, *Mapping, Utility expansion, Cost analysis, Florida.

Due to a population that has tripled since 1980, the community of Jupiter in Palm Beach County, Florida planned to expand the current 13 mgd capacity plant to 34 mgd. The expanded plant will employ lime softening of raw water from a shallow aquifer and reverse osmosis of raw water from the Florida Aquifer. A computer-aided design and drafting (CADD) system was used to computerized Jupiter's water system atlas. The ability to display the entire database or various portions of it at different scales and to depict only specified combinations of data are principal advantages of the system. Other advantages of the computer atlas include its flexibility of scale, ability to be easily modified for a variety of applications, and greater accuracy than hand drawn maps if data are valid. Disadvantages include the high cost to produce the program, difficulty in obtaining accurate data, necessity of frequent updates, and the inability to symbolize some elements on a computer. All of these factors need to be considered in a decision to implement this system. (White-Reimer-PTT)
W88-09659

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

FINANCIAL IMPLICATION OF EUTROPHICATION,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5C.
W88-09052

ECONOMICS OF NATURAL RESOURCE DAMAGE CLAIMS,
Johns Hopkins Univ., Baltimore, MD.
J. J. Boland.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 61-72, 1 tab.

Descriptors: *Economic aspects, *Legal aspects, *Damage claims, *Water resources, *Cost, Legislation, Environmental effects, Regulations, Value, Damage assessment, Public participating, Bias.

Among the innovative features of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as it applies to groundwater litigation, is the provision for recovery of natural resource damages in addition to the costs of response and remedy. CERCLA did not define natural resource damages, nor did it suggest how they might be measured. On August 1, 1986, the Department of the Interior (DOI) published final rules governing the assessment of natural resource damages. The rule governing Type B natural resource damage assessements occupies over 27 pages of the Federal Register; a number of valuable innovations are included. This Rule makes some useful contributions to improved damage assessment practice. It provides a logical process, a means for participation by interested parties, and set of clear criteria for identifying and quantifying injury to natural resource services. The Rule contains, however, some incorrect and inconsistent economic concepts, which can be expected to cause significant bias in the resulting damage assessment. The Rule consistently confuses damage to natural resources with damage to private individuals, applying principles of tort law to the identification of those damages. The 'public' vs. 'private' distinction is meaningless on its face, since all beneficial uses of resource services are ultimately 'private.' The association of 'private' with 'for-profit' activities introduces another distinction which is irrelevant to the task of assessing changes in the value of a natural resource. The Rule also misuses the concept of intrinsic value, employing it only as a substitute for the wholly unrelated category of use value. In addition, the Rule also insists on the use of market price as the preferred measure of damage, even though this method is without theoretical support in such an application. The Rule, therefore, precludes the calculation of damages which derive from: (1) future uses of resources so degraded that they have no current beneficial use; (2) uses by business entities (as opposed to individuals); (3) intrinsic values such as option, existence, or bequest value; and (4) changes in consumer surplus (when the market price or the appraisal method is used). Pending application of the Rule in the context of an actual assessment, the full quantitative significance of these exclusions cannot be known. (See also W88-09374) (Lantz-PTT)
W88-09379

METERING UTILITY SERVICES: EVALUATION AND MAINTENANCE,
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-09539

HISTORICAL ASPECTS OF IRRIGATION AGRICULTURE AND RIVER REGULATION IN THE MURRAY-DARLING BASIN, AUSTRALIA,
Sydney Univ. (Australia).

B. R. Davidson.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 131-140, April-June 1988. 2 tab, 40 ref.

Descriptors: *Water rates, *Water use efficiency, *Pricing, *Economic aspects, *Irrigation, Catchment basins, Farming, Water rights, Markets, Irrigation efficiency, Irrigation water, Australia, History, Costs.

River regulation in Australia is a feature of the last one hundred years. Irrigation farms were established along the River Murray in the late 1880's and on the Murrumbidgee in the first quarter of the twentieth century. These demonstrated that such labor-intensive types of farming were unprofitable in Australia. The additional profits obtained by irrigation farmers were not sufficient to pay for the reservoirs and distributary works required and these had to be paid for by the State. Water was sold to farmers at a price which was only sufficient to maintain the projects. Political pressure led to a further increase in the construction of reservoirs and the area irrigated in the Murray-Darling basin expanded from 0.6-million hectares in 1945 to 1.6-million hectares in 1979. As irrigation practices improved, farm profits increased, but the price of water continued to be based on the cost of maintaining the projects. This led to increased profits being built into the price of irrigated land. Low water prices encouraged farmers to over-irrigate and aggravated the problem of rising water tables and salination. It is suggested that the efficiency of water usage in irrigation could be improved by transferring the existing water rights from the state to irrigators, and making them transferable from one irrigator to another or from irrigators to other users at prices negotiated in a free market. Such a system would ensure that water was put to its optimum use, reducing wastage and minimizing detrimental effects of over-use. The water price established in such a market could be used to calculate whether the marginal returns from irrigation and other uses were high enough to justify the construction of new projects. (Author's abstract)
W88-09723

COST-BENEFIT ANALYSIS OF FLOOD-PLAIN ZONING,
Montreal Univ. (Quebec). Dept. of Economics.
For primary bibliographic entry see Field 6F.
W88-09984

UNDERGROUND STORAGE TANK DISPOSAL: ALTERNATIVES, ECONOMICS, AND ENVIRONMENTAL COSTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5E.
W88-10036

METERING UTILITY SERVICES: THEORY AND WATER SUPPLY APPLICATIONS,
Washington Univ., Seattle. Dept. of Civil Engineering.
J. R. Lund.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8706624. Ph.D Dissertation, 1986. 208 p, 25 fig, 16 tab, 188 ref, 5 append.

Descriptors: *Water supply, *Cost-benefit analysis, *Economic aspects, *Public investment, *Municipal water, Pricing, Profit, Linear programming, Systems analysis, Optimization.

Methods were developed for analyzing the utility of metering public utilities, particularly municipal water supplies. Techniques for efficient meter installation and maintenance were derived and methods of pricing metered and unmetered service connections are proposed. Findings indicate that metering should be examined on a case by case basis to determined the justification for efficiency, equity, or profitability. Where metering is economically efficient, it is also profitable to the utility. But profitable use of metering is not necessarily efficient. The decision to meter may vary with the utility's motivation as a profit-maximizing firm or a public service utility with social welfare objectives. Since water demand is impermanent, long-range marginal costs are inappropriate for incorporating capacity expansion deferral benefits into the decision to meter. Expansion linear programming should be used to incorporate expansion deferral benefits. Mathematical optimization techniques are also useful for finding least-cost meter installation schedules, determining least-cost meter maintenance strategies, and setting metered and unmetered service rates. The minimum present value cost approach to scheduling meter maintenance is superior to theoretical and practical meter maintenance approaches in the water supply industry. (Cremmins-AEPCO)
W88-10084

6D. Water Demand

WATER RESOURCE MANAGEMENT PLANNING CRITERIA FOR VASHON/MAURY ISLAND, WASHINGTON: A CASE STUDY,
For primary bibliographic entry see Field 4B.
W88-09275

CONTROL OF PEAK WATER DEMANDS,
For primary bibliographic entry see Field 3D.
W88-09658

INSTREAM FLOW STUDIES IN PERSPECTIVE,
Tulsa Univ., OK. Faculty of Biological Science.
J. A. Gore, and J. M. Nestler.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 93-101, April-June 1988. 2 fig, 48 ref.

Descriptors: *Instream Flow Incremental Methodology, *Instream flow, *Water use, *Computer programs, *Model studies, Natural water use, Water users, Water resources development, Planning, Habitats, Aquatic habitats, Fish, Management planning.

The Instream Flow Incremental Methodology (IFIM) has been subject to criticisms, including its apparent imprecision, inability to predict discharge-biomass relationships, lack of independence of hydraulic variables, and omission of predation/competition as variables in assessing the dynamics of aquatic populations and communities. The criticisms of the methodology are addressed, stressing three themes. First, the development of IFIM to its present form is described. The goal of the method is to relate biotic values in equivalent terms to those used to estimate other beneficial uses of water. As such the engineering concepts of hydraulic simulation and suitability criteria play a strong role in the model. Previous studies suggest that IFIM appears to perform defensibly in cold-water systems but less well in more complex cool-water and warmwater systems. Second, the strengths of IFIM are considered and the type of environmental problems it is suited to address are described. Research suggests that biotic responses vary dramatically as certain threshold discharges are approached and it is suggested that biomass predictions are inappropriate with current versions of IFIM. Its greatest utility is shown to be in assessing the impacts of water resources development on habitat availability for aquatic organisms. Third, the limitations of IFIM are presented, including those that appear to have merit and those that arise from misapplication or misunderstanding of the methodology. It is suggested that suitability criteria be developed on a site specific basis and include depth-velocity dependent functions. The added predictive power obtained by incorporation of coefficients of biological interactions to this management model is probably not justified by the expense required to obtain the data. As a tool, IFIM maximizes generality and precision at the expense of ecological reality but this does not detract from its utility to analyze water resource issues. (Author's abstract)
W88-09720

TERMINOLOGY FOR DESCRIBING ON-FARM IRRIGATION WATER DEMANDS,
Calgary Univ. (Alberta). Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W88-09745

TEST OF WEIGHTED USABLE AREA ESTIMATES DERIVED FROM A PHABSIM MODEL FOR INSTREAM FLOW STUDIES ON TROUT STREAMS,
Wyoming Game and Fish Dept., Cheyenne.
A. L. Conder, and T. C. Annear.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 3, p 339-350, Summer 1987. 2 fig, 8 tab, 22 ref.

Descriptors: *Stream fisheries, *Aquatic productivity, *Fish populations, *Instream flow requirements, *Water use, *Model studies, *Trout, Physical habitat simulation model, Stream gradient, Aquatic habitats, Wyoming.

An assessment was made of the biological validity of weighted usable area (WUA) from the physical habitat simulation (PHABSIM) model based on standing crops of trout (Salvelinus and Salmo spp.) measured in Wyoming streams and standing crops predicted by the habitat quality index (HQI). Tests were made in trout streams for (1) validity of the HQI, (2) relationships between WUA and measured standing crops in different streams, and (3) relationships between WUA and the HQI within streams. Significant correlation ($r=0.934$; $P<0.05$) was found between HQI scores and trout standing crop during the low-flow period. No significant correlation was found for WUA and the measured standing crop among different streams; correlation coefficients for all tests were either near zero or moderately negative. Significant positive correlation ($P<0.05$) did exist for 7 of the 60 within-stream analyses of WUA vs. HQI; 19 other positive correlations were strong ($r>0.90$), but statistical significance was limited by the number of data points at each site. Although positive correlations were expected for all 60 cases, 18 tests showed a negative correlation, 3 of which were significant. Analyses indicated that trout species, stream size, and stream gradient influence the validity of the within-stream relationship between WUA and the trout standing crop predicted by the HQI. Among test streams with steeper gradients and where velocity exerted the greatest influence on the HQI score, a positive correlation was observed in all cases, regardless of stream size or dominant species. When an attribute other than velocity has the greatest influence on trout density with change in discharge, WUA estimates may be invalid. This observation indicates that a relationship between WUA and trout standing crop may exist, but the nature of the relationship is likely to be unique for each stream. (Author's abstract)
W88-09819

RIVER RECREATION BOATING IMPACTS,
Toronto Univ. (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 4C.
W88-09987

MULTIOBJECTIVE RESERVOIR OPERATION USING FORECASTS OF WATER SUPPLY AND WATER USE,
Interstate Commission on the Potomac River Basin, Rockville, MD.
For primary bibliographic entry see Field 6A.
W88-10018

MODEL FOR OPTIMIZATION OF SOCIO-ECONOMIC FISHERY VALUES ON THE RIO GRANDE IN NEW MEXICO,
New Mexico State Univ., Las Cruces. Dept. of Fishery and Wildlife Sciences.
R. Cole, F. Ward, T. Ward, R. Deitner, and Fiore.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-161450/AS. Price codes A12 in paper copy; A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report

No. 223, May 1987. 246 p, 26 fig, 4 tab, 121 ref, append. Contract No. 516-74-65 (NMGF) State Projects No. 1423683 and 1345642.

Descriptors: *Sport fishing, *Computer models, *Optimization, *Fish habitats, *Rio Grande basin, Mathematical models, New Mexico, Computer programs, Economic benefits, Social values, Model studies.

A mathematical model which simulates sport-fish production yield, and economic value in the Rio Grande basin of New Mexico is described. The model links hydrologic, biologic, and economic components into a mathematical representation of fisheries habitat, fishery dynamics, economic benefits, and income generated by sport-fishing in New Mexico. The model has a research version programmed in FORTRAN and a user-friendly version programmed in APL. Model users have numerous entries to model outputs and for simulating management decisions. In the user-friendly version the user can enter the model and obtain output on reservoir surface area, reservoir volume, water levels, discharge in connecting waters, total plant production, allochthonous loads of suspended organics, zooplankton production, zoobenthos production, total fish production, fish guild density by size class, fish guild yield by size class, fish guild surplus yield by size class, economic benefits to New Mexico anglers, and county income generated. The model users can modify water volume flowing through the basin by month, water stored in each reservoir, water discharged through connecting waters, material concentrations (suspended solids, total phosphorus, total nitrogen) in the water, site access, and site quality. (Cole-NM St. Univ.)
W88-10022

OWNERSHIP AND EFFICIENCY IN THE WATER SUPPLY INDUSTRY: AN APPLICATION OF THE NONPARAMETRIC PROGRAMMING APPROACH TO EFFICIENCY MEASUREMENT,
Southern Illinois Univ. at Carbondale. Dept. of Economics.
For primary bibliographic entry see Field 5F.
W88-10079

METERING UTILITY SERVICES: THEORY AND WATER SUPPLY APPLICATIONS,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6C.
W88-10084

6E. Water Law and Institutions

SUPERFUND: CIVILIAN FEDERAL AGENCIES SLOW TO CLEAN UP HAZARDOUS WASTE.
General Accounting Office, Washington, DC. Resources, Community and Economic Development Div.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-233060. Price codes: A03 in paper copy, A01 in microfiche. July 1987. 36 p, 4 fig, 4 tab, 2 append. Report No. GAO/RCED-87-153.

Descriptors: *Waste disposal, *Hazardous wastes, *Superfund, *Cleanup operations,*Water pollution treatment, *Toxic wastes, Water pollution prevention, Waste dumps, Hazardous materials, Water pollution control, Legal aspects, Soil contamination, Performance evaluation, Groundwater pollution.

As the owner of one-third of the nation's land area, the federal government is responsible for cleaning up perhaps thousands of sites where uncontained hazardous wastes are contaminating soil and groundwater. Since 1980, federal agencies have been required by law to determine whether their facilities and lands contain abandoned or uncontrolled hazardous wastes and to take any necessary corrective actions. Civilian agencies have been slow to identify, assess, and clean up their hazardous waste sites. Since Comprehensive Environmental Response, Compensation, and Liability Act ('Superfund') enactment, the agencies have identified 1,882 potential sites, assessed about half of them to determine whether they required cleanup, and cleaned up 78 of the 511 sites found to need it. As of September 1986, only 4 of the 11 agencies had completed their site identification efforts; the other 7 were still compiling their site inventories. None of the agencies had completed their assessments, although all but 2 of them believed they will meet the April 1988 congressional deadline. Only 15% of the 511 sites found to require corrective action have been cleaned up, and the agencies generally would not predict when their cleanup efforts would be complete or how much they would cost. (Geiger-PTT)
W88-09053

RISK ASSESSMENT UNDER THE REVISED NATIONAL CONTINGENCY PLAN OF SUPERFUND,
Kirkland and Ellis, Washington, DC.
For primary bibliographic entry see Field 5E.
W88-09057

CASE STUDIES OF HAZARDOUS WASTE PROBLEMS IN LOUISIANA,
Louisiana Dept. of Natural Resources, Baton Rouge.
For primary bibliographic entry see Field 5E.
W88-09058

DETERMINING THE IMPACTS ON HUMAN HEALTH ATTRIBUTABLE TO HAZARDOUS WASTE SITES,
Centers for Disease Control, Atlanta, GA. Center for Environmental Health.
For primary bibliographic entry see Field 5C.
W88-09059

INCORPORATING RISK ASSESSMENT INTO THE RESOURCE CONSERVATION AND RECOVERY ACT REGULATORY PROCESS,
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
C. Haymore.
IN: Risk Assessment at Hazardous Waste Sites. American Chemical Society, Washington, DC. 1982. p 117-123.

Descriptors: *Risks, *Hazardous wastes, *Regulations, *Policy making, *Waste disposal, *Resource Conservation and Recovery Act, *Public health, Environmental effects, Cost analysis, Models, Hazardous materials, Industrial wastes, Land disposal.

The types of risk assessments being conducted to develop regulations for the control of hazardous wastes under the Resource Conservation and Recovery Act are reviewed. Better data and Executive Order 12291 have spurred the development of more detailed risk assessment models in regulatory analyses. The first of three projects is a broad policy overview of the entire hazardous waste program that focuses on the risks and costs of different combinations of wastes, technologies, and environmental settings. The second project is a series of Regulatory Impact Analyses that will review the first wave of several regulations. The third project is designed to tailor regulations to specific industries and waste streams. (See also W88-09056) (Author's abstract)
W88-09064

SAFETY EVALUATION OF PESTICIDES IN GROUND WATER,
CIBA-GEIGY Corp., Greensboro, NC. Agricultural Div.
For primary bibliographic entry see Field 5A.
W88-09112

INDUSTRY PERSPECTIVE ON PESTICIDE AND GROUND WATER LEGISLATION,
CIBA-GEIGY Corp., Greensboro, NC. Agricultural Div.
L. C. Newby, and C. G. Rock.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 478-487, 21 ref.

Descriptors: *Pesticides, *Water quality control, *Water quality, *Chemical industry, *Groundwater pollution, *Legal aspects, *Legislation, Regulations, Agricultural chemicals, Groundwater.

Groundwater must be protected - society is in agreement. It is the focus and level of regulatory protection which concerns the agricultural chemical industry. Groundwater is not pure. It contains many substances, both natural and man-made, for most of which, minimal safety information is available. With continually improving analytical capability, additional products are certain to be detected in even the most pristine aquifers. A few pesticides have already been detected and it seems likely that others will be found. In most cases, these will be substantially below the levels which could result in adverse effects. Regulatory efforts should be directed to establishing acceptable levels, while industry should act to minimize the movement of all chemicals to groundwaters. Acceptable levels of chemicals in groundwater should be uniform throughout the nation. They should be set at the federal level or by uniform procedures among the state agencies. (See also W88-09089) (Author's abstract)
W88-09114

GROUND WATER REGULATIONS: IMPACT, PUBLIC ACCEPTANCE, AND ENFORCEMENT,
Wisconsin Dept. of Agriculture, Madison. Trade and Consumer Protection.
O. R. Ehart, G. Chesters, and K. J. Sherman.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 488-498, 1 tab, 16 ref.

Descriptors: *Pesticides, *Water quality control, *Water quality, *Water law, *Social impact, *Attitudes, *Enforcement, *Groundwater pollution, *Legal aspects, Legislation, Regulations, Agricultural chemicals, Groundwater, Wisconsin.

Sanctioning pesticides for agricultural use was based on equating environmental and public health risks to crop production benefits. More recently, the introduction of groundwater protection into pesticide regulations has modified the equation by adding other elements of protection. During the past decade pesticide issues have been emotionally charged with the extremists' views most notably reported. The public believes that groundwater deserves greater protection than surface water because improving the quality of contaminated groundwater is more difficult and costly. This coupled with the users', particularly those in rural areas, concerns that their drinking water is being polluted, has lead to acceptance of groundwater regulations by pesticide users often opposed to regulation. Enforcement of regulations, based on acceptable tolerance levels of pesticides in groundwater, must rely on quality-assured data. Regulatory models, used as an information source, could be helpful in evaluating the consequences of pesticide use. Enforcement sanctions follow traditional civil and criminal remedies but innovative cost incentives might be needed to accelerate protection programs. Mechanisms of implementation of land management controls vary from state to state. The development and administration of the Aldicarb Rule in Wisconsin and the development, administration and enforcement of the Wisconsin Groundwater Law were detailed and it is suggested that, with modifications to provide for different geographical, climatological, legal and political variables, the methods of land management controls be adopted by other states. (See also W88-09089) (Wood-PTT)
W88-09115

EMERGING ROLE OF PESTICIDE REGULATION IN FLORIDA DUE TO GROUND WATER CONTAMINATION,
Florida State Dept. of Environmental Regulation, Tallahassee.

H. L. Rhodes.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, Washington, DC. 1986. p 541-547.

Descriptors: *Pesticides, *Florida, *Water quality control, *Groundwater pollution, *Legal aspects, *Legislation, *Regulations, Agricultural chemicals, Groundwater, Water quality.

The sequence of events that led to a stronger environmental pesticide program in the State of Florida was described. Prior to 1983, the State of Florida did not have an active pesticide program. There was very little impetus to protect the groundwater from the effects of pesticide contamination. The technical findings, the news media publications and the resultant political actions changed the climate in the state to one of serious concern over groundwater contamination by pesticides. In 1983, the State Legislature made broad, major inroads into legislation and funding of programs that provided the state with a comprehensive pesticide program that looked at the environmental impacts of a wide range of pesticide activities. The discoveries of the pesticides aldicarb and EDB in the groundwater made these programs possible. (See also W88-09089) (Author's abstract)
W88-09118

CONSIDERING PESTICIDE POTENTIAL FOR REACHING GROUND WATER IN THE REGISTRATION OF PESTICIDES,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W88-09119

NECESSARY INVOLVEMENT AND RESPONSIBILITY OF SEPARATE ENTITIES IN PLANNING AND PERFORMANCE OF AQUIFER RESTORATION,
C. A. Rich.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 3-10, 1 tab.

Descriptors: *Aquifer managment, *Project planning, *Management planning, *Rehabilitation, *Operating policies, *Decision making, *Interdisciplinary studies, *Water pollution treatment, *Scheduling, Long-term planning, Coordination, Financial feasibility, Groundwater management.

Effective aquifer restoration must rely upon variables that are as flexible and diverse as the numerous contamination sites and the more numerous entities involved in cleanup at these sites. This paper describes the necessary working roles and coordination of these separate entities, the contractors or individuals within various organizations, when they are called upon to interpret hydrogeologic, chemical and engineering complexities, as well as site-specific technical feasibilities and collected raw data. Such coordination is critical insurance for a responsibly planned and performed remedial effort that will reduce liability exposure and long-term risk to the environment. The current status of aquifer restoration is experimental, with remedial activities guided by court action, schematics or back of envelope decisions by field personnel on the job. Unfortunately, the logical progression of designed feasibility studies is oftentimes predicated on criteria remotely indifferent to site-specific factors, i.e., variations in approach may depend solely on financial appropriation or degree of public interest. Compounding this problem is a general lack of funds to address necessary detail; due to decreased federal funding for the EPA, states have been forced to assume the unanticipated burden of addressing their numerous designated cleanup sites. Some of the most commonly encountered participants in aquifer restoration programs can be characterized into entity groups, including owner/operator/manager, soil scientist, toxicologist, field technicians, and landowners. This paper reviewed six project cases to illustrate the importance of separate entity involvement in developing a suitably representative characterization of site conditions during aquifer cleanup planning. Analysis of the cases suggested that occurrence of entity involvement should progress in a logical sequence, i.e., a hydrogeologist must be engaged prior to a water well contractor, and an engineer prior to excavation or construction activities. Also, there does not seem to be a direct relationship between occurrence of entity involvement and existing or perceived impacts. Entity involvement in these cases was more directly attributable to availability of funding even though inaction could be projected to result in worsening of the current situation. (See also W88-09129) (Friedmann-PTT)
W88-09130

MASSACHUSETTS WATER-SUPPLY CONTAMINATION CORRECTION PROGRAM,
D. R. Bowley.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 171-174, 3 fig.

Descriptors: *Water pollution treatment, *Water pollution control, *Legislation, *Massachussets, *Municipal water, *Groundwater pollution *Water pollution, *Public waters, *Financing, *Cleanup, Wells, Governments supports, Potable water, Plumes, Environmental policy, Bacteria, Algae, Grants, Economic aspects, Organic compounds, Leachates, Nitrates.

The Massachusetts Legislature was confronted in the spring of 1982 with a list of 36 municipal wells (including two well fields) and 29 private wells contaminated and closed in 29 communities. On July 7, Chapter 286 of the Acts of 1982 was passed. The act allowed the Dept. of Environmental Quality Engineering to expend funds to correct contamination of public water supplies and to augment contaminated public (and certain private) water supplies. Primary emphasis was on cleanup, though permission was granted to fund studies and to control contamination by plume management. A grant program was established and in 1983, applications were invited for $8.5 million in funding. Applications received included projects for cleanup of contamination by organic chemicals, leachate, nitrates, bacteria, and algae. (See also W88-09129) (Friedmann-PTT)
W88-09149

WATER-QUALITY MONITORING AT HAZARDOUS WASTE DISPOSAL SITES: IS PUBLIC HEALTH PROTECTION POSSIBLE THROUGH MONITORING PROGRAMS,
Texas Tech Univ., Lubbock. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W88-09151

CONJUNCTIVE USE--FIRST BY ACCIDENT, NOW BY MANAGEMENT,
Nebraska Dept. of Water Resources, Omaha.
For primary bibliographic entry see Field 4B.
W88-09241

CONJUNCTIVE USE OF GROUND WATER AND SURFACE WATER IN THE SOUTH PLATTE RIVER BASIN--A CASE STUDY OF THE CENTRAL COLORADO WATER CONSERVANCY DISTRICT,
Central Colorado Water Conservancy District, Greeley.
For primary bibliographic entry see Field 4B.
W88-09243

MANAGEMENT OF DECLINING GROUND WATER LEVELS IN PART OF EASTERN WASHINGTON,
For primary bibliographic entry see Field 4B.
W88-09255

GROUND WATER MANAGEMENT STRATEGIES FOR ARIZONA,
Arizona Dept. of Water Resources, Phoenix.
For primary bibliographic entry see Field 4B.
W88-09257

GROUND WATER MANAGEMENT IN OWENS VALLEY, CALIFORNIA,
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 4B.
W88-09260

GROUND-SURFACE WATER TECHNICAL AND QUASI-LEGAL RELATIONSHIPS,
Tipton and Kalmach, Inc., Denver, CO.
For primary bibliographic entry see Field 2A.
W88-09261

GROUND WATER RIGHTS IN CALIFORNIA,
J. F. Mann.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 181-186, 5 ref.

Descriptors: *Water law, *Groundwater management, *Water rights, *California, Beneficial use, Riparian rights, Appropriation, Water allocation, Judicial decisions.

California has a complex system of water rights. Although the basic rights are found in both the riparian and appropriative concepts, there have been many legislative and judicial modifications. Two types of groundwater are recognized by the state. Those that flow in known and definite channels fall under the jurisdiction of the state. Rights to this water can be obtained by appropriation, or under the riparian doctrine if the lands overlie the underflow. All other groundwater is considered percolating and not subject to the direct control of the state. In the late 19th century, percolating water could be removed by the overlying landowner without limit. In 1903, rights in basin water were declared correlative, meaning the landowner, in event of shortage, had to share the water with others tapping the same supply. A further erosion of the overlying right came in 1974, when a court decision declared that a public agency could store groundwater beneath private lands without compensation. In many basins, especially in southern California, where rights have been adjudicated, there are many restrictions on the pumping of groundwater, ranging from complete prohibition to permissible upon the payment for expensive imported water. There is no groundwater management on the state level; this is considered a local matter. Since 1970 the counties have become increasingly involved in groundwater management through the Environmental Impact Report. (See also W88-09240) (Author's abstract)
W88-09262

CONTROLS OVER INTERSTATE TRANSFERS OF GROUND WATER POST-SPORHASE: STATE AND FEDERAL OPTIONS,
G. W. Sherk.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 187-193, 3 ref.

Descriptors: *Water law, *Groundwater, *Water transfer, *Sporhase decision, *Judicial decisions, *State jurisdiction, *Federal jurisdiction, Irrigation, Interbasin transfer.

The U.S. Supreme Court, in Sporhase v. Nebraska (July 2, 1982), held groundwater to be an article of commerce and invalidated Nebraska's statute governing interstate transfers of groundwater as constituting an impermissible state burden on interstate commerce. Under this decision, states continue to have the authority to regulate the interstate transfer of groundwater for legitimate conservation and preservation purposes. In the first case interpreting the Sporhase decision, the U.S. District Court for New Mexico ruled in El Paso v. Reynolds (January 17, 1983) that New Mexico's restrictions on the export of groundwater placed an impermissible burden on interstate commerce. In this decision, which is currently being appealed, the District Court further limited state authority to regulate the

interstate transfer of groundwater by defining water for basic human survival as the maximum quantity of water a state could restrict from export. Legislative options available include the following: do nothing, allowing the Sporhase decision to stand; partially reverse Sporhase either by focusing on specific uses of water or by focusing on the extent of the burden imposed on interstate commerce by state laws regulating interstate water transfers; totally reverse Sporhase, which would probably be inadequate; or establish mandatory compacts. State options include conforming with Sporhase, entering into new state compacts, and apportioning water under equitable apportionment litigation. (See also W88-09240) (Cassar-PTT)
W88-09263

FORGING THE NEW WATER LAW: PUBLIC REGULATION OF PROPRIETARY GROUND WATER RIGHTS,
McCutcheon, Doyle, Brown and Enersen, San Francisco, CA.
A. Rossman, and M. J. Steel.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 194-215.

Descriptors: *Water law, *Groundwater management, *Water rights, *Public policy, *California, *Proprietary power, *Groundwater, Regulations, Owens Valley, Los Angeles, Inyo County.

Inyo County, California, has a dispute with Los Angeles Department of Water and Power concerning groundwater extractions from the County. The County has pursued litigation under the California Environmental Quality Act and an unsuccessful plea for state-supervised groundwater regulation. Since these efforts were inadequate, a local ordinance was enacted to regulate the Owens Valley Basin consistently with California law. The ordinance declares that Owens Valley groundwater forms a significant resource of the state that must be managed in trust for the benefit of the state's residents. It creates a county water department and commission with authority to approve a water management plan. Wells must be registered, and applications to extract must be submitted annually. These provisions are authorized by the self-enforcing provision of the 1928 reasonable and beneficial amendment to the California constitution. Recent developments in this dispute include a tentative superior court ruling to invalidate the ordinance, Inyo County's efforts to secure immediate California Supreme Court review, and the efforts by both Inyo and Los Angeles to avoid further litigation by adopting a joint groundwater management plan. (See also W88-09240) (Cassar-PTT)
W88-09264

TOWARD A COST-BENEFIT ASSESSMENT OF GROUND WATER QUALITY REGULATION,
Salt River Project, Phoenix, AZ.
For primary bibliographic entry see Field 5G.
W88-09265

GROUND WATER QUALITY MANAGEMENT IN ARIZONA,
For primary bibliographic entry see Field 5G.
W88-09266

EVIDENTIARY CONSIDERATIONS RELATED TO THE USE OF GROUND WATER MODELS IN LITIGATION,
Moses, Wittemyer, Harrison, and Woodruff, Boulder, CO.
D. M. Brown, and H. L. Martin.
IN: Proceedings of NWWA Western Regional Conference on Ground Water Management. San Diego, California, October 23-26, 1983. National Water Well Association. National Water Well Association, Worthington, OH. 1984. p 356-361, 4 ref.

Descriptors: *Groundwater, *Geohyrology, *Water law, *Model studies, *Litigation, Judicial decisions, Hydrology.

Groundwater models are increasingly used for factual determinations in judicial and administrative proceedings. To be used in such proceedings the results of modeling and the related expert testimony must be admissible under the applicable rules of evidence. The new Federal Rules of Evidence, which have been substantially adopted by most states, have removed many of the archaic restrictions to presentation of technical information and expert opinions. To be admissible, evidence must be relevant, presented by a competent witness; opinions are admissible if given by an expert in the field. Common objections to admission of expert testimony include (1) confusing, misleading or inefficient testimony, (2) hearsay, (3) lack of original material (the new rules allow computer printouts of data and derived charts and summaries), (4) no foundation for the evidence. Pretrial preparation of the proponent involves obtaining an expert witness with a knowledge of all phases of data gathering efforts, preparing the information so that it is admissible in court, and educating the attorneys on the technicalities of groundwater analysis. Preparation of the opponent involves learning about the proponent's expert witnesses and data. Problems that often arise involve propriety nature of this information and claims of protection under the work product rule. In many circumstances these problems can be overcome. (See also W88-09240) (Cassar-PTT)
W88-09280

RECOMMENDED REVISIONS FOR SAN DIEGO COUNTY'S RURAL GROUND WATER POLICY AND GROUND WATER INVESTIGATION PRACTICES,
For primary bibliographic entry see Field 4B.
W88-09281

TECHNICAL ENFORCEMENT GUIDANCE DOCUMENT FOR GROUND-WATER MONITORING SYSTEMS,
Environmental Protection Agency, Washington, DC. Office of Waste Programs Enforcement.
P. L. Cook.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 1-4.

Descriptors: *Landfills, *Resource Conservation and Recovery Act, *Standards, *Groundwater monitoring, *Waste disposal, *Legal aspects, *Geohydrology, *Monitoring wells, Statistical methods, Design criteria, Design standards, Aquifers, Groundwater.

This presentation summarizes the characteristics and nationales behind the Resource Conservation and Recovery Act (RCRA) Technical Enforcement Guidance Document (TEGD). The Office of Waste Programs Enforcement of EPA was charged with the task of developing a guidance document to aid in evaluating the technical adequacy of groundwater monitoring systems at hazardous waste facilities. The document consolidates in one place for the first time EPA technical policies and requirements as well as recognized geologic and engineering practices necessary to meet the performance based regulations for groundwater monitoring systems at RCRA facilities. It is intended to be used by all individuals involved in addressing RCRA groundwater monitoring problems including regional and state enforcement staff, permit writers and field inspectors. The key for proper use of the TEGD is to understand that it is a guidance document and must be used flexibly by trained professionals employing informed judgement to site-specific situations. It is not to be used as a rigid standard. The TEGD document places major emphasis on the following issues: detailed site hydrogeologic characterization, well location, monitoring well design and construction, and statistical analysis of monitoring data. (See also W88-09283) (Alexander-PTT)
W88-09284

IMPACT OF THE CHANGED RCRA REGULATORY ENVIRONMENT UPON FACILITIES WITH GROUND WATER MONITORING,
Geraghty and Miller, Inc., Washington, PA.
R. M. Melvin.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 170-184. 7 ref.

Descriptors: *Regulations, *Landfills, *Resource Conservation and Recovery Act, *Water law, *Legal aspects, *Superfund, *Hazardous materials, *Monitoring, *Groundwater monitoring, Water pollution sources, Permits, Leachates, Geohydrology, Hydrology, Aquifers, Groundwater.

Corrective action for past releases from solid waste management units (SWMU's) probably is the single most significant impact of The Hazardous and Solid Waste Amendments of 1984 (HSWA) on land disposal facilities. It will be considered during the ongoing permit application review process. The 40 CFR 270 required analyses for Appendix VIII hazardous constituents (required as part of the definition of any plumes originating from Resource Conservation and Recovery Act (RCRA) units and/or SWMU's) has been altered by EPA's efforts to adjust the scope of such analyses. Since some SWMU's are either on or are being considered for the Superfund (CERCLA) National Priority List (NPL), the CERCLA program and the RCRA program objectives overlap. EPA has decided that the CERCLA concerns at active RCRA sites which are not on the NPL will be addressed in the RCRA permitting process as long as progress is made towards properly addressing groundwater contamination. The RCRA permitting process for land disposal facilities will vary in complexity, depending upon a particular state's current program authorization status. All RCRA land disposal facilities must be permitted by November 8, 1988. The additional HSWA minimum technological and retrofitting requirements for surface impoundments have caused many facility owners/operators to close their units, raising questions as to the need for post closure permits vs. 'clean closures'. (See also W88-09283) (Author's abstract)
W88-09296

UNDERGROUND STORAGE TANK MONITORING IN CALIFORNIA: AN EVALUATION OF RECENT LEGISLATION,
Kleinfelder (J.H.) and Associates, Walnut Creek, CA.
M. S. Bonkowski, and R. Rinehart.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 185-194. 1 tab.

Descriptors: *Regulations, *Permits, *California, *Soil contamination, *Underground storage tanks, *Groundwater monitoring, *Water law, *Legal aspects, *Monitoring wells, Vadose zone, State jurisdiction, Water pollution control, Geohydrology, Hydrology, Aquifers, Groundwater.

Existing California law requires any owner of any underground storage tank installed on or before January 1, 1984 to outfit the facility with a monitoring system capable of detecting unauthorized releases before July 1, 1985. As a result of delays in the rule making process, Assembly Bill 2239 amends Section 25283, allowing the local agency to implement Chapter 6.7 by January 1, 1986. Assembly Bill 2239 further permits the local agency to issue an interim permit to a tank owner to operate the tanks. The local agency then has until March 1, 1986 to approve, modify, or disapprove the monitoring system. The owner of the underground tank must install the monitoring system within 6 months of the local agency approval. Under the existing state regulations there are 8 monitoring alternatives available to underground storage tank owners. They are: (1) monthly tank testing; (2) vapor or other vadose zone monitoring wells, groundwater monitoring wells and soil sampling; (3) vadose zone monitoring, soil sampling and annual tank testing; (4) groundwater monitoring and soil sampling; (5) inventory recon-

ciliation, annual tank testing and pipeline leak detectors; (6) inventory reconciliation, annual tank testing, pipeline leak detectors and vadose or groundwater monitoring wells; (7) weekly tank gauging and annual tank testing; and (8) an interim method (for use up to 3 years) that requires annual tank testing, inventory reconciliation and tank removal. (See also W88-09283) (Author's abstract)
W88-09297

REVIEW OF MATERIALS USED IN MONITORING AND MONITORING WELL CONSTRUCTION,
Waste Management, Inc., Oak Brook, IL.
M. N. Sara.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 330-337. 1 tab.

Descriptors: *Resource Conservation and Recovery Act, *Standards, *Polyvinyl chloride, *Groundwater monitoring, *Monitoring wells, *Design criteria, *Design standards, Groundwater pollution, Groundwater management, Geohydrology, Hydrology, Aquifers, Groundwater, Reviews, Steflon, Stainless steel.

Since little or no guidance was provided on appropriate use of casing material at the time the Resource Conservation and Recovery Act (RCRA) regulations were promulgated, most operators installed polyvinyl chloride (PVC) casing in both the original and subsequent monitoring systems. This material was readily available, fairly inexpensive, and had a long history in water supply. In the intervening years, a number of questions were raised as to exactly what casing material is appropriate for use in a monitoring well, and some research was initiated to provide guidance in this area. The controversy surrounds the August 1985 draft guidance document entitled 'RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD),' which was intended to help EPA and State enforcement officials decide whether specific elements of an owner/operator's groundwater monitoring system satisfy the RCRA requirements. The TEGD states that only Teflon or stainless steel are acceptable for use as screen or casing in new well installations. While the EPA has changed its approach from requiring the use of these materials for the fully cased well to only that portion located within the saturated zone, the guidance requirement raises serious questions as to its technical validity. The results of the authors is experiments show that for all materials exposed, the net sorption is nominally zero. While some experimental error associated with these tests is conceded, the result still is obvious: rigid PVC well casing performs as well as, if not better than, Teflon or stainless steel. In general, there is little, if any, real justification for the substitution of Teflon or stainless steel for PVC as the material of choice for construction of monitoring wells for RCRA facilities. (See also W88-09283) (Alexander-PTT)
W88-09310

PROCEEDINGS OF THE 8TH NATIONAL GROUND WATER QUALITY SYMPOSIUM: 'ANATOMY OF SUPERFUND'.
National Water Well Association, Dublin, OH.
For primary bibliographic entry see Field 5G.
W88-09374

SUPERFUND: SIGNIFICANT ACCOMPLISHMENTS,
ICF, Inc., Washington, DC.
J. R. Janis, and E. Berk.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 3-11.

Descriptors: *Water pollution control, *Enforcement, *Legal aspects, *Cleanup operations, *Superfund, Management planning, Regulations, Remedies, Private sector, Water pollution treatment, Feasibility studies, National Priorities List, Remedial investigations.

Superfund is responsible for much more than long-term cleanups of the 'big sites,' although the 'remedial actions' aimed at eliminating the threats such sites present have justifiably been at the center of the program. The first step in the Superfund program is site identification and preliminary investigation. After identifying the sites, the second major step is to determine the appropriate course of action. The Superfund program, therefore, conducts full-scale remedial investigations and feasibility studies (R1/FS) to plan its remedial action at any site on the National Priorities List (NPL). The third major remedial step is constructing the remedy. Once a specific course of action has been selected for a site, it has to be designed and carried out. While the remedial actions have been underway, the Superfund program has also been responding to emergencies caused by spills or other releases of hazardous substances to the environment. These emergency responses are conducted under Comprehensive Environmental Response, Compensation and Liability Act's (CERCLA) 'removal action' authorities, which are also used for site stabilization and containment, as well as for cleanup actions of limited cost and duration. Some Superfund response actions are conducted by the private firms or individuals determined to be responsible for the problem. CERCLA actually provides the Superfund program with two types of authorities by which to secure cleanup: (1) direct government action, and (2) authority to compel private parties to take action. Responsible parties can also be made to pay, before or after the fact, for an action conducted by the government. In assessing the accomplishments of Superfund, credit must be given to the fact that the Superfund program has had to develop new approaches to rectify problems embedded in scientific uncertainty, relying on scant experience. These technical and social challenges have been met, to varying extends, over the past six years. (See also W88-09374) (Lantz-PTT)
W88-09375

REMEDIAL INVESTIGATIONS/FEASIBILITY STUDIES UNDER SUPERFUND,
Camp, Dresser and McKee, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5G.
W88-09377

SURVEYS OF REMEDIAL ACTIONS AT SUPERFUND SITES,
Soil and Material Engineers, Inc., Bordentown, NJ.
For primary bibliographic entry see Field 5G.
W88-09378

ECONOMICS OF NATURAL RESOURCE DAMAGE CLAIMS,
Johns Hopkins Univ., Baltimore, MD.
For primary bibliographic entry see Field 6C.
W88-09379

ENTROPY RACES SUPERFUND,
Office of Technology Assessment, Washington, DC.
J. S. Hirschhorn.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 99-106, 1 tab.

Descriptors: *Water pollution control, *Chemical wastes, *Cost analysis, *Cleanup operations, *Superfund, *Entropy, *Water pollution treatment, Waste disposal, Disposal sites, Management planning, Optimization.

The basic law of cleanup is simple: chemical wastes will not stay put. Using entropy as the key underlying principle, a strategy for Superfund addresses this extremely complex program. First priority should be identifying Superfund sites. Second priority should be performing preliminary assessment on sites to decide when a recontrol action is necessary and, if it is, doing it quickly. Third priority should be providing resources for studies and permanent cleanups. Spending that ignores entropic effects is bound to be ineffective and misdirected. The odds are that many sites will get worse from inattention and that those that are cleaned up will require repeated cleanups. The challenge posed by Superfund is to decide how to optimize spending for the long term good of many people. Responding to demands for immediate and expensive cleanups for relatively few sites, particularly when expensive cleanups are not technically sound or sometimes even necessary, is not a good long term strategy. Only a scientifically sound Superfund strategy can earn the public's trust in the Federal cleanup program. (See also W88-09374) (Lantz-PTT)
W88-09381

SUPERFUND - REPAIRS IN ORDER,
Delaware State Dept. of Natural Resources and Environmental Control, Dover.
For primary bibliographic entry see Field 5G.
W88-09382

ALTERNATIVE APPROACHES TO RECORD OF DECISION,
Clean Site, Inc., Alexandria, VA.
C. R. Glore.
IN: Proceedings of the 8th National Ground Water Quality Symposium: 'Anatomy of Superfund'. September 23-25, 1986, Kansas City, Missouri. 1986. p 125-129.

Descriptors: *Record of Decision, *Superfund, *Water pollution treatment, *Waste management, *Cleanup operations, Groundwater pollution, Path of pollutants, Case studies, In-situ treatment, Incineration, Biodegradation, Vacuum extraction, Encapsulation, Case studies, Pennsylvania, Southwestern United States.

Deferral of the groundwater Remedial Design/Remedial Action (RD/RA) decision naturally results in a delay in the complete cleanup of a site. In practical terms this delay has both a positive and a negative aspect. Although the delay allows whatever contamination that is present in the groundwater to continue to spread while further studies are being completed the deferral of an RD/RA has some effects which may outweigh the potential hazards of a delay in remediation. An obvious advantage is that the process of understanding the geohydrology better means that the solution finally chosen will be a better one. Also, during the reevaluation of the geohydrology of the site, alternative technologies for remediation can often be explored more thoroughly than was possible in the time frame of the original Remedial Investigation/Feasibility Study. Alternative technologies are those that apply a solution or method of implementation of the Record of Decision that is different from a standard removal or encapsulation technique; examples are on site incineration by high technology methods such as the plasma torch, incineration in portable rotary kilns or existing rotary cement kilns, biodegradation, and vacuum extraction in the vadose zone. Three case studies, are cited as examples where alternative and innovative solutions to onsite containment or total destruction of hazardous wastes were employed (two Pennsylvania sites, one site in the Southwestern U.S.). (See also W88-09374) (Lantz-PTT)
W88-09383

STATE INVOLVEMENT IN AN EPA LEAD SUPERFUND REMEDIAL ACTION,
Iowa Dept. of Natural Resources, Des Moines.
For primary bibliographic entry see Field 5G.
W88-09384

CLEAN WATER ACT PERMIT GUIDANCE MANUAL,
Smith and Schnacke, Dayton, OH.
For primary bibliographic entry see Field 5G.
W88-09399

WATER QUALITY-BASED CONTROLS AND ECOSYSTEM RECOVERY,
Environmental Protection Agency, Washington, DC. Monitoring and Data Support Div.

For primary bibliographic entry see Field 5G.
W88-09460

POLITICAL AND SOCIAL FACTORS IN THE PATUXENT RIVER CLEANUP AGREEMENT,
ERM, Inc., Exton, PA.
For primary bibliographic entry see Field 5G.
W88-09461

FEDERAL CORRECTIVE ACTION REQUIREMENTS FOR PETROLEUM UNDERGROUND STORAGE TANKS,
ICF, Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W88-09485

HEALTH EFFECTS OF DRINKING WATER CONTAMINANTS,
American Water Works Association Research Foundation, Denver, CO.
For primary bibliographic entry see Field 5C.
W88-09643

COASTAL MANAGEMENT ISSUES FOR THE MOUTH OF THE RIVER MURRAY, SOUTH AUSTRALIA,
South Australia Dept. of Environment and Planning, Adelaide.
For primary bibliographic entry see Field 2L.
W88-09763

COASTAL MANAGEMENT ISSUES FOR THE MOUTH OF THE RIVER MURRAY, SOUTH AUSTRALIA,
South Australia Dept. of Environment and Planning, Adelaide.
N. Harvey.
Coastal Management CZMJBF, Vol. 16, p 139-149, 1988. 1 fig, 28 ref.

Descriptors: *Coastal zone management, *Sedimentation, *Estuarine environment, *Management planning, *Governmental interrelations, *Interagency cooperation, Saline-freshwater interfaces, Coastal streams, Australia, River Murray, Marine sediments, Estuaries, Rivers, Obstruction to flow.

The management issues relating to the potential closure of the mouth of Australia's largest river due to marine sediment are examined. It is important to maintain the river flow to avoid rising salinity levels in adjoining Coorong Lagoon that would cause ecological changes that could damage existing fishing and tourism industries. Potential flooding is also a concern. The mouth was artificially opened in 1981 following its closure and at that time monitoring was begun. Possible management options include: (1) clearing the mouth with fresh water stored in adjacent lakes, (2) dredging, (3) provision of temporary groins, and (4) installation of drift fencing. One of the major unresolved issues is the question of responsibility and funding, which has arisen because of overlapping jurisdictions on either side of the river mouth and a lack of jurisdiction for the mouth itself, which is an administrative boundary. (White-Reimer-PTT)
W88-09955

FINANCIAL RESPONSIBILITY PROVISIONS FOR UNDERGROUND TANKS IN VIRGINIA,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5G.
W88-10037

ECONOMIC AND INSTITUTIONAL ASPECTS OF RISK AND LIABILITY IN THE CONTROL OF GROUNDWATER POLLUTION,
Wisconsin Univ., Madison. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W88-10043

IMPLEMENTATION OF INTERGOVERNMENTAL REGULATORY PROGRAMS: SECTION 402 OF THE FEDERAL WATER POLLUTION CONTROL ACT.
Washington State Univ., Pullman. Dept. of Political Science.
P. S. Wassenberg.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8610390. Ph.D Dissertation, 1985. 154 p, 3 fig, 9 tab, 164 ref, append.

Descriptors: *Regulations, *Policy making, *Political aspects, *Water pollution control, *Federal jurisdiction, *State jurisdiction, Decision making, Administrative decisions.

A framework is proposed to explain the extent to which intergovernmental regulatory policies have resulted in state involvement in implementation, based on the point source pollution control program (NPDES) under the Federal Water Pollution Control Act Amendments of 1972. The framework is derived from the Mazmanian and Sabatier model. Thirty-five of the fifty states applied for NPDES program authority and all applicants were successful. Four factors related to application were: the potential influence of the target group, the severity of the target problem, Republican Party Dominance, and state wealth. The dual federalist view of the positions of the federal and state governments regarding the intergovernmental division of authority is not supported by the results of the analysis of the NPDES program. (Cremmins-AEPCO)
W88-10078

6F. Nonstructural Alternatives

HANDBOOK OF HAZARDOUS WASTE MANAGEMENT FOR SMALL QUANTITY GENERATORS,
For primary bibliographic entry see Field 5E.
W88-09030

GROUND WATER MANAGEMENT: SAN DIEGO STYLE,
San Diego County, CA.
For primary bibliographic entry see Field 4B.
W88-09259

MUNICIPAL LAND USE REGULATION AND THE GREAT LAKES SHORELINE HAZARD IN ONTARIO,
Guelph Univ. (Ontario). Dept. of Geography.
R. D. Kreutzwiser.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 142-147, 1988. 1 fig, 3 tab, 13 ref.

Descriptors: *Great Lakes, *Nonstructural alternatives, *Land use, *Lakes, *Erosion, *Flood protection, *Shores, Lake shores, Shore protection, Planning, Great Lakes, Lake Huron, Lake Erie, Lake Ontario, Coastal zone management, Water level fluctuation, Zoning.

The application of the Ontario municipal land use planning process to the Great Lakes shoreline flood and erosion hazard during the decade following high lake levels of 1973 was assessed. Zoning bylaws and other planning documents for 20 selected shoreline municipalities were examined. Development occurring within the 100-year flood and erosion zone of each municipality was determined using air photos and municipal building permit files. By 1983 all study municipalities had recognized the shoreline hazard in their planning documents, but only a minority had comprehensive development controls in place. During the 1973-1982 period, an average 37.5% increase in development in the hazard zone among the municipalities was measured. While some of this development was permitted on condition of flood proofing or installation of erosion control works, more can be done to minimize an increase in hazard susceptibility. This study lends support to a recent Ontario government initiative designating regional conservation authorities as implementing agencies for shoreline hazard management. (Author's abstract)
W88-09547

COASTAL MANAGEMENT ISSUES FOR THE MOUTH OF THE RIVER MURRAY, SOUTH AUSTRALIA,
South Australia Dept. of Environment and Planning, Adelaide.
For primary bibliographic entry see Field 6E.
W88-09955

COST-BENEFIT ANALYSIS OF FLOOD-PLAIN ZONING,
Montreal Univ. (Quebec). Dept. of Economics.
P. Ouellette, D. Leblanc, N. El-Jabi, and J. Rousselle.
Journal of Water Resources Planning and Management JWPED5, Vol. 114, No. 3, p 326-334, May 1988. 1 fig, 3 tab, 6 ref.

Descriptors: *Cost analysis, *Floods, *Flood plain zoning, *Flood plains, *Cost-benefit analysis, Probabilistic process, Model studies, Mathematical models.

The economic yield of a flood-plain zoning program is measured by cost-benefit analysis. The methodology entails the use of a probabilistic hydroeconomic model to evaluate expected flood damages with and without zoning. The application shows that this type of program, albeit cost-effective overall may be unacceptable for various reasons to the various parties involved. (Author's abstract)
W88-09984

6G. Ecologic Impact Of Water Development

PACIFIC NORTHWEST RIVERS STUDY ASSESSMENT GUIDELINES: WASHINGTON STATE.
Washington State Energy Office, Olympia.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-011161. Price codes: A04 in paper copy, A01 in microfiche. 1986. 55 p, 1 tab, 6 append. Compiled by Steven Zubalik. Report No. DOE/BP-758. Washington State Energy Office Report No. WAOENG-87-03. Bonneville Power Administration Contract No. DE-AI79-84BP19369.

Descriptors: *Project planning, *Fisheries, *Pacific Northwest, *Data collections, *Standards, *Hydroelectric power, *Environmental impact statement, *Washington, Wildlife, Rivers, Environmental effects, Institutional constraints, Electric power production, Water resources development, Archaeology, Recreation.

The Pacific Northwest Rivers Study was designed to produce a consistent and verifiable river resource data basse and to identify resource considerations which might affect hydropower development. The process that participants followed to complete the Pacific Northwest Rivers Study are described along with assessment methods for each river resource category, the types of data collected, and the criteria for the evaluation and ranking of river reaches. Resource considerations which might affect hydropower development are identified. The assessment process involved identification of river resource categories, creation of an inventory of information, identification of experts to produce useful data during the study period, development of criteria and standards, evaluation of individual resource categories, displaying and reviewing category findings, creation of a data management system, and presenting and documenting project findings. To standardize the assessment process and the resulting products, a number of regionwide production guidelines were established. Included were the following: factors to be evaluated (resident fish, wildlife, natural features, cultural features, recreation, and legal constraints); geographic scope; river reach determination; value classes (resource significance rating assigned to each river segment for a given resource category); and, data presentation (data entry forms and maps). (Geiger-PTT)
W88-09032

RESOURCE DOCUMENT FOR CONSIDERATION OF THE NEWBERG AREA AQUIFER AS A SOLE SOURCE AQUIFER.
Environmental Protection Agency, Seattle, WA. Office of Ground Water.
For primary bibliographic entry see Field 2F.
W88-09033

GROUND WATER MANAGEMENT IN OWENS VALLEY, CALIFORNIA,
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 4B.
W88-09260

PALAEOHYDROLOGY IN PRACTICE: A RIVER BASIN ANALYSIS.
For primary bibliographic entry see Field 2A.
W88-09360

INTRODUCTION,
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09361

MODELS FOR PALAEOHYDROLOGY IN PRACTICE,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09362

CONTEMPORARY RIVER: THE BASIN,
University Coll. of Wales, Aberystwyth.
For primary bibliographic entry see Field 2E.
W88-09363

CLIMATIC CHANGE OVER THE LAST MILLENIUM IN CENTRAL BRITAIN,
Birmingham Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09366

ENVIRONMENTAL CHANGE AND HYDROLOGICAL RESPONSE: FLOODING IN THE UPPER SEVERN CATCHMENT,
University Coll. of Wales, Aberystwyth. Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09367

HISTORICAL RIVER CHANNEL CHANGES,
University Coll. of Wales, Aberystwyth.
For primary bibliographic entry see Field 2E.
W88-09368

LONG-TERM SEDIMENT STORAGE IN THE SEVERN AND WYE CATCHMENTS,
Leicester Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-09371

EVOLUTION OF EUROPEAN RIVERS - A COMPLEX RESPONSE,
Polish Academy of Sciences, Krakow. Dept. of Geomorphology and Hydrology.
For primary bibliographic entry see Field 2E.
W88-09372

PALAEOHYDROLOGICAL SYNTHESIS AND APPLICATION,
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09373

EFFECTS OF RIVER REGULATION ON FLOODING OF A RIPARIAN RED GUM FOREST ON THE RIVER MURRAY, AUSTRALIA,
Melbourne Univ., Parkville (Australia). Forestry Section.
For primary bibliographic entry see Field 4A.
W88-09718

ACCUMULATION OF FINE SEDIMENT WITHIN SUBSTRATE GRAVELS ALONG TWO REGULATED RIVERS, UK,
Loughborough Univ. of Technology (England). Dept. of Geography.
G. E. Petts.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 141-153, April-June 1988. 3 fig, 8 tab, 33 ref. NERC Research Grant GR3/5142.

Descriptors: *Regulated rivers, *Sedimentation, *Fine sediments, *Flow regulation, *Water management effects, Sediment distribution, Rivers, Gravel, England, Distribution patterns, Spatial distribution, Silting, Scotland, River Daer, River Derwent.

The channel-bed materials have a marked influence on the biota of lotic systems. Experimental studies suggest that flow regulation, specifically the reduction in magnitude of flood events, may lead to the infiltration of fine particles into, and the concentration of these sediments within, open framework gravels downstream from tributary sediment sources. The distribution of fines (sub-2 mm) within channel substrate gravels along two regulated rivers in upland Britain (River Daer, Scotland; River Derwent, England) were examined. Bulk- and freeze-sample techniques were used: the latter yielded volumes of fines five times those of the former. This emphasizes the problem of wash-out during bulk-sample collection, especially in compact, coarse gravel substrates. Nevertheless, the same spatial pattern was revealed by both data sets. Along both regulated rivers, the proportion of the substrate finer than 2 mm exceeds 20 per cent, by weight, below tributary confluences, contrasting with values for non-regulated sites of less than 5 percent. Both the amount and size of matrix sediments decrease downstream from the confluences. The spatial scale of the impact is small and the resultant ecological consequences of substrate sedimentation are likely to be localized. (Author's abstract)
W88-09724

IMPORTANCE OF STREAMLINING IN INFLUENCING FISH COMMUNITY STRUCTURE IN CHANNELIZED AND UNCHANNELIZED REACHES OF A PRAIRIE STREAM,
Iowa State Univ., Ames. Dept. of Animal Ecology.
D. L. Scarnecchia.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 155-166, April-June 1988. 4 fig, 3 tab, 30 ref.

Descriptors: *Streams, *Channeling, *Fish populations, *Water management effects, *Environmental effects, *Fish physiology, Streamlined fish, Fish, Water currents, Channel improvement, Stream improvement, Populations, Population density, Iowa, Pillsbury Creek, Family diversity, Body shape.

Channelized and unchannelized sections of a prairie stream (Pillsbury Creek, northwestern Iowa) were compared to determine how differences in microhabitats affected fish species abundance and diversity and the incidence of streamlined species. Channelized sections had significantly more fish per unit area ($P<0.05$) but significantly less biomass ($P<0.05$). Green sunfish (Lepomis cyanellus) and stonecats (Noturus flavus) were common in the unchannelized sections but rare or absent in the channelized ones. Small native minnows (Cyprinidae), especially the bigmouth shiner (Notropis dorsalis), dominated channelized sections. Species diversity was lower in channelized sections, but differences were not statistically significant ($P=0.06$). Family diversity was significantly lower in channelized sections ($P<0.05$). Channelized sections exhibited less heterogeneity of widths, velocities and substrates and contained more streamlined forms than did unchannelized sections. Unchannelized sections, characterized by greater diversity of velocities and substrate types, supported more centrarchids and ictalurids, fish that are not optimally streamlined. Although many other factors besides streamlining influence the fish community structure in streams, in reaches without refuges from the current, streamlining may be a factor determining which species persist there. (Author's abstract)
W88-09725

MONITORING THE IMPACT OF DAMS ON THE DOWNSTREAM PHYSICAL ENVIRONMENT IN THE TROPICS,
Bayero Univ., Kano (Nigeria). Dept. of Geography.
E. A. Olofin.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 167-174, April-June 1988. 2 fig, 2 tab, 24 ref.

Descriptors: *Environmental impact assessment, *Dam effects, *Water management effects, *Environmental effects, *Monitoring, *Tropical regions, Ecological effects, Tropic zone, Dams, Case studies, Nigeria, Kano River basin, Chalawa River basin, River basins, Erosion, Sediment yield, Vegetation.

In general, the assessment of environmental impact of dams is not undertaken in feasibility surveys of dam-related projects in the Tropics, as it should be. Consequently, post-implementation investigations (mostly by research students) continue to reveal undesirable effects. The lack of appropriate data on which to base predictions in proposed projects, or to assess environmental impacts of ongoing ones, is a major problem. It is argued that continuous monitoring of existing projects can help fill this data gap. Such monitoring should cover the entire basin affected, taking into account environmental variables of the upstream, reservoir, and downstream systems. The systems downstream of dams in the Kano and Chalawa Rivers in the Kano State of Nigeria were considered. Variables of importance include: soil erosion and sediment yield; channel morphometry; discharge and runoff pattern and volume; and changes in vegetation cover, water chemistry and water quality. Field measurements and observations, laboratory analyses, and statistical inferences are required to yield acceptable results. Such results are expected to better the understanding (through impact assessment) and management of existing projects and to aid wise predictions (at the feasibility stage) of environmental effects of new projects. (Wood-PTT)
W88-09726

HISTORICAL CHANGES OF A LARGE RIVER IN AN URBAN AREA: THE GARONNE RIVER, TOULOUSE, FRANCE,
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
For primary bibliographic entry see Field 4C.
W88-09728

COASTAL MANAGEMENT ISSUES FOR THE MOUTH OF THE RIVER MURRAY, SOUTH AUSTRALIA,
South Australia Dept. of Environment and Planning, Adelaide.
For primary bibliographic entry see Field 2L.
W88-09763

BENTHIC ECOLOGY OF RIVERS IN THE BLUE MOUNTAINS (JAMAICA) PRIOR TO CONSTRUCTION OF A WATER REGULATION SCHEME,
Newcastle upon Tyne Univ. (England). Dept. of Zoology.
P. J. Boon, B. P. Jupp, and D. G. Lee.
Archiv fuer Hydrobiologie, Supplement Vol. 74, AHBSA8, No. 3, p 315-355, December 1986. 5 fig, 14 tab, 106 ref.

Descriptors: *Water resources development, *Jamaica, *Species composition, *Streams, *Limnology, *Physical properties, Aquatic plants, Limiting nutrients, Aquatic animals, Seasonal variation, Ecological effects, Population dynamics, Aquatic

habitats, Rivers, Blue Mountains, Agricultural runoff, Rainfall, Rivers, Forests, Erosion.

The physico-chemical environment and benthic biology of Jamaican Blue Mountain streams are described. Aquatic vegetation is sparse, the most numerous taxa being epipelic diatoms. The generally low nutrient concentrations of these waters, together with shading and erosion by spates probably accounts for the poor phytobenthos development. Invertebrate communities contain relatively few species and chiefly comprise Trichoptera, Ephemerooptera and Diptera. Baetis sp. and Smicridea jamaicensis accounted for 72% of the animals collected. Detailed studies of the Yallahs and Buff Bay rivers show that invertebrate population densities are far greater in the former, probably due to differences in phytobenthic cover and habitat stability between the two rivers. Species diversity tends to decrease downstream and may be correlated with increasing distance from heavily forested upland slopes. Some variation in population levels between sampling sites is associated with local enrichment from farm runoff. Several species of invertebrates reached their maximum numbers during the two driest periods of the year, suggesting that seasonal rainfall patterns are important in influencing invertebrate abundance. A study of the life-cycle of S. jamaicensis indicates continuous emergence and recruitment. It is suggested that the Yallahs Pipeline project currently under construction may increase nitrate levels in Mona Reservoir and lead to enhanced algal blooms. (Alexander-PTT)
W88-09878

7. RESOURCES DATA

7A. Network Design

GROUND WATER SAMPLING: ADDRESSING THE TURBULENT INCONSISTENCIES,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Solid Waste Management.
J. Feld, J. P. Connelly, and D. E. Lindorff.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 237-255. 8 fig, 1 tab, 24 ref, append.

Descriptors: *Quality control, *Laboratory certification, *Monitoring wells, *Sampling, *Standards, *Groundwater monitoring, Groundwater management, Measuring instruments, Data interpretation, Aquifers, Groundwater, Wisconsin, Performance evaluation, Network design.

As part of an ongoing process to ensure that groundwater data are reliable, the Wisconsin Department of Natural Resources (WDNR) has developed proposed rules for monitoring well installation, guidelines for groundwater sampling and rules for certifying analytical laboratories. This paper presents the WDNR's approach to developing groundwater sampling guidelines; identifies some of the issues and inconsistencies regarding groundwater sampling that are debated within the professional community; and highlights recommendations for controversial topics relating to well purging, sample withdrawal, sample filtering and field cleaning. The guidelines emphasize the importance of thorough sampling preparation, consistent sampling procedures and detailed documentation. While developing these guidelines, the WDNR surveyed solid waste and wastewater facility owners and operators in Wisconsin to identify sampling procedures they currently use to monitor groundwater. This paper incorporates the results of this survey, which were used to help develop realistic recommendations and to evaluate the effects these recommendations would have on regulated facilities. (See also W88-08991) (Author's abstract)
W88-09004

ROLE OF AMBIENT GROUND WATER MONITORING IN STANDARD SETTING AND GROUND WATER PROTECTION STRATEGY DEVELOPMENT IN MINNESOTA,
Minnesota Pollution Control Agency, St. Paul.
G. V. Sabel.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 257-264. 2 fig, 2 tab.

Descriptors: *Sampling, *Nonpoint pollution sources, *Minnesota, *Standards, *Groundwater monitoring, *Monitoring wells, *Groundwater management, *Water quality, Aquifers, Water chemistry, Drinking water, Data interpretation, Sampling devices, Watersheds, Leachates, Waste disposal, Groundwater, Quality control, Management planning, Computers.

Minnesota has conducted an ambient groundwater monitoring program since 1978, collecting data from thirteen major aquifers for basic water chemistry parameters as well as selected pollutants. As the body of information gathered grows, increasing use is being made of the data for various planning, rulemaking and site-specific projects. The program also provides a vehicle for monitoring nonpoint source pollution covering large areas of rural Minnesota. This paper outlines some of these uses, citing specific examples of ways in which the data have been beneficial. Suggestions are also made as to changes which would make the ambient monitoring program more effective. In addition, brief descriptions of the sample collection technique (stabilization procedure) and data management system are provided. Examples given include the use of ambient groundwater monitoring data in a selected watershed to evaluate the effectiveness of land use changes aimed at improving water quality. Ambient groundwater monitoring data has also been used to help justify standards set for pollutants from landfill leachates in groundwater in the vicinity of solid waste management facilities. Examples are shown of the comparison of ambient water quality with the proposed standards, illustrating the relationship of background water quality, Minnesota Department of Health's Recommended Acceptable Limits for domestic well water and the standards proposed by the Minnesota Pollution Control Agency. Discussion is also provided of the use of ambient data in site-specific groundwater evaluations, and a computer-generated report is shown that compares the quality of water in a particular well with aquifer median values, statewide averages and drinking water standards. (See also W88-08991) (Author's abstract)
W88-09005

NUMERICAL EVALUATION OF MONITORING WELL DESIGN,
GeoTrans, Inc., Herndon, VA.
R. M. Cohen, and R. R. Rabold.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 267-283. 11 fig, 2 tab, 11 ref.

Descriptors: *SATURN, *Groundwater monitoring, *Model studies, *Mathematical models, *Groundwater pollution, *Finite element method, *Monitoring wells, Design criteria, Design standards, Hydraulic conductivity, Permeability coefficient, Water quality, Path of pollutants, Stochastic process, Anisotropy, Simulation, Groundwater, Niagara Falls, Aquifers, New York, Monitoring, Groundwater management.

During the course of remedial investigations in Niagara Falls, New York, it has been necessary to evaluate the groundwater quality and hydraulic characteristics of 5- to 30-ft thick overburden formations. Many of the monitoring wells completed to these formations consist of a partially-penetrating screen (5-ft at the base of the formation) with a fully-penetrating sandpack. Questions regarding how this well design influences the source of sampled groundwater were examined using an extremely fine axisymmetric grid with SATURN, a two-dimensional, finite-element groundwater model, and a particle tracking post-processor. A discrete sensitivity analysis was made to determine how flow patterns induced by pumping at 1 gpm are affected by: different screen and sandpack configurations, the ratio of sandpack to formation hydraulic conductivities, heterogeneity, anisotropy, and sandpack thickness. The simulations show that the source (and chemistry given a non-uniform chemical distribution) of groundwater sampled will vary considerably depending on a number of factors. (See also W88-08991) (Author's abstract)
W88-09006

MONITOR WELLS FOR DEPTH-DISCRETE SAMPLING: A COST-EFFECTIVE ALTERNATIVE DESIGN,
Geoscience Consultants Ltd., Albuquerque, NM.
J. C. Hunter, R. T. Hicks, M. W. Selke, and J. L. Appel.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 299-310. 3 fig, 2 tab, 4 ref.

Descriptors: *Cluster wells, *Well installation, *Design criteria, *Monitoring wells, *Cost analysis, *Groundwater monitoring, Groundwater management, Aquifers, Mathematical studies, Performance evaluation, Economic aspects, Sampling devices, Groundwater, Design standards, Performance evaluation.

Alternative well design to cluster wells incorporates segmented, pack-isolated screens, inert borehole sealants and controlled, simultaneous pumping of all screened segments. This configuration was evaluated for hydraulic performance by numerical modeling, and model results show that there is little potential for vertical flow in the filter pack or in the aquifer adjacent to the well. Wells of this design therefore should be capable of collecting depth-discrete, representative samples from the levels at which the screens are placed. When compared to the costs of cluster wells at a site where groundwater lies at a depth of 200 feet, a three-screen alternative well costs $23,700 as opposed to $48,600 for a three-well cluster. This represents a savings of $24,900 per sampling location, or approximately 50% of well installation costs. Alternatively, twice as many locations could be evaluated for the same well costs. Although the design has not been field tested, it shows considerable potential for improved monitoring at lower costs. (See also W88-08991) (Author's abstract)
W88-09008

USE OF ODEX DRILLING SYSTEM FOR MONITORING WELL INSTALLATION IN AQUIFER CONTAINING GLACIAL BOULDERS,
J. A. Baker, T. J. Holdrege, D. J. Buck, and E. J. Hubbard.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 363-372. 5 fig.

Descriptors: *Drilling, *Odex system, *Boulders, *Leakage, *Monitoring wells, *Groundwater monitoring, Groundwater management, Design criteria, Design standards, Performance evaluation, Comparison studies, Aquifers, Groundwater, California, Fuel, Oil pollution.

Unusual drilling conditions were encountered during investigation of a leaking underground diesel fuel tank located at 6200 feet MSL near Donner Pass in the Sierra Nevada mountains of California. The 12,000 gallon steel tank, which had been leaking an undetermined length of time, was buried in a clean granitic sand containing numerous boulders, some approaching the size of small automobiles. Drilling with traditional hollow stem augers was attempted, with a maximum depth obtained of 3 feet before refusal. Since the objective of the investigation was to determine the extent of the contaminant plume while adhering to hazardous waste drilling protocols, drilling methods which introduce drilling fluids (drilling mud or water) were not acceptable. The drilling method selected had to have the capability to: (1) drill without introduction of fluids into the unconfined

aquifer, (2) obtain undisturbed samples with the standard split-spoon sampler, (3) drill through moderately weathered granitic boulders, and (4) accomplish the above tasks in a relatively efficient manner in order to reduce the cost to the client. Only one drilling method was found which could do the required work. The ODEX drilling system, using a downhole percussion hammer with casing advance, was used to advantage on this difficult site. Several monitoring wells were installed and utilized to complete the study. (See also W88-08991) (Author's abstract)
W88-09012

USE OF A MATHEMATICAL MODEL TO DESIGN LYSIMETER NETWORKS FOR SURFACE IMPOUNDMENTS AND LANDFILLS,
In-Situ, Inc., Laramie, WY.
A. C. Bumb, C. R. McKee, R. B. Evans, and L. A. Eccles.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 401-423. 16 fig, 2 tab, 37 ref. EPA Cooperative Agreement No. CR 812189-01-0.

Descriptors: *Monitoring, *Landfills, *Model studies, *Lysimeters, *Network design, *Leachates, *Groundwater monitoring, *Groundwater pollution, Aeration zone, Water pollution sources, Groundwater management, Path of pollutants, Soil properties, Hydraulic conductivity, Permeability coefficient, Waste disposal, Surveys, Mathematical models, Mathematical studies, Aquifers, Groundwater.

Sampling of soil pore moisture in the vadose zone underneath land disposal facilities (landfills and surface impoundments) for hazardous waste has been suggested as an 'early warning system' to detect leakage from these facilities. Some states require vadose zone moisture sampling at such sites. Given a leak of a particular size, mathematical models can estimate the necessary moisture sample volume collection times and lysimeter spacings to guarantee detection of the leak. Examination of 47 hazardous waste sites existing in 1984 indicated that most were located in areas with water tables too shallow to permit vadose zone detection monitoring. Several of the sites with adequate vadose zones had soils which could be described as loamy sand, silt loam, or silty clay. For a particular loamy sand with a saturated hydraulic conductivity of 0.000001 cm/sec, the maximum ceramic lysimeter spacing is 15.5 feet at a depth of 30 feet to collect a moisture sample of 10 ml in one week. For a silt loam, maximum lysimeter spacing would be 17 feet at a depth of 15 feet. For silty clays, the maximum lysimeter spacing is 7 feet at a depth of 2 feet; maximum emplacement depth is about 9 feet. Calculations show that in some soils, suction lysimeters will not be able to collect usable moisture samples. Since soil properties vary widely, appropriate soil measurements and modeling must be performed at each disposal facility to estimate lysimeter performance and to select locations for emplacement. (See also W88-08991) (Author's abstract)
W88-09014

FACTORS AFFECTING THE UTILITY OF SOIL VAPOR ASSESSMENT DATA,
EA Engineering, Science, and Technology, Inc., Sparks, MD.
H. J. Reisinger, D. R. Burris, L. R. Cessar, and G. D. McCleary.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 425-435. 3 fig, 8 ref.

Descriptors: *Monitoring, *Soil-gas data, *Sampling, *Groundwater monitoring, Groundwater management, Analytical methods, Soil properties, Data interpretation, Errors, Detection limits, Path of pollutants, Aquifers, Groundwater pollution, Groundwater, Physical properties, Quality control, Aquifer characteristics.

The factors with the potential to affect soil vapor data can be thought of as being either of a physical-site-related nature or a chemical nature. Among the physical factors are the presence of confining layers or structures between the contaminant source and the soil vapor monitoring point, failure to adequately seal the sampling point to the atmosphere, and nonhomogeneity of the effective porosity of the soil matrix. These factors could introduce a strong negative bias to the data, which may result in an erroneous 'no contamination' conclusion. Chemical factors affecting soil vapor data include the degree to which the compounds of interest lend themselves to the vapor techniques, the appropriateness of the detection and analytical system, and data quality. The importance of understanding and considering the factors that affect the utility of soil vapor data is illustrated in a discussion of two sites at which the soil vapor contaminant assessment technique was used. (See also W88-08991) (Author's abstract)
W88-09015

SOIL GAS SAMPLING STRATEGIES: DEEP VS. SHALLOW AQUIFERS,
D. L. Marrin.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 437-454. 4 fig, 1 tab, 9 ref.

Descriptors: *Soil-gas sampling, *Monitoring, *Groundwater monitoring, *Groundwater pollution, *Aquifers, *Organic compounds, *Design criteria, Data interpretation, Physical properties, Soil properties, Chlorinated hydrocarbons, Hydrocarbons, Prediction, Sampling devices, Groundwater, Analytical methods, Groundwater management, Aquifer characteristics.

The analysis of shallow soil gas samples for volatile organic chemicals (VOCs) has become an increasingly applied remote detection technique for delineating subsurface plumes. Both the design and interpretation of soil gas investigations are dependent on the depth of the contaminated aquifer as well as compound-specific factors. Aquifer depth affects the steepness of chemical concentration gradients and consequently the flux of soil gas contaminants. The thickness of the vadose zone through which VOCs must diffuse also influences the optimal sampling depths and the probability of encountering localized barriers to gas diffusion such as clay lenses or perched water. Chemicals which are relatively resistant to environmental degradation (e.g., chlorinated solvents) have been detected from aquifers as deep as 200 feet below the ground surface. Conversely, readily oxidized chemicals such as petroleum hydrocarbons are sometimes absent from the shallow soil gas overlying aquifers at 10 to 15 feet deep. Aquifer depth affects soil-gas/ground water correlations and the feasibility of predicting VOC concentrations in groundwater from VOC concentrations in soil gas. Generally, the degree of correlation between soil gas and groundwater concentrations increases with aquifer depth. Relatively poor site-specific correlations are characteristic of very shallow aquifers because slight variations in elevation of water table or land surface result in significant changes in shallow soil gas concentrations. Variations in groundwater elevation or topography overlying a deep aquifer do not significantly affect VOC concentrations in shallow soil gas. The selection of sampling equipment (e.g., passive or sorbent samplers vs. grab or pumping apparatus) is also determined, in part, by the depth of contamination. (See also W88-08991) (Author's abstract)
W88-09016

NEUTRON MONITORING IN THE UNSATURATED ZONE,
LeRoy Crandall and Associates, Glendale, CA.
R. J. Brose, and R. W. Shatz.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 455-467. 4 fig, 21 ref.

Descriptors: *Monitoring, *Soil moisture meters, *Liquid wastes, *Neutrons, *Groundwater monitoring, *Monitoring wells, *Sampling devices, Measuring instruments, Soil water, Mapping, Design criteria, Groundwater, Monitoring, Aeration zone, Groundwater management, Analytical methods.

An unsaturated zone detection monitoring system recently installed at a new liquid waste impoundment facility utilizes neutron logging equipment to measure soil moisture changes surrounding both vertical access casings, installed within and adjacent to the surface impoundment, and in a series of horizontal access casings installed beneath the surface impoundment liner system. Neutron monitoring of the unsaturated zone provides reproducible, non-destructive results, using an instrument that does not require direct contact with the subsurface materials and is not dedicated to one sampling location. The horizontal access casings increase the detection coverage of the unsaturated zone monitoring system by allowing accurate moisture content measurements directly beneath the liner system. The combination of vertical and horizontal measurements produces a three dimensional grid suitable for modeling. Linear spacing configurations can be adjusted within the monitoring network to define plume boundaries if seepage occurs from the impoundment. Background data obtained from the unsaturated zone monitoring system indicate that soil moisture changes of less than 1% by volume can be accurately and consistently detected. The system is currently being successfully used to map and monitor soil moisture changes produced by preconstruction surface water application practices and provide leak detection coverage for the impoundment facility. (See also W88-08991) (Author's abstract)
W88-09017

IN-SITU HYDRAULIC CONDUCTIVITY MEASUREMENTS OF SLOWLY PERMEABLE MATERIALS USING A MODIFIED GUELPH PERMEAMETER AND THEGUELPH INFILTRAMETER,
Guelph Univ. (Ontario). Dept. of Land Resource Science.
N. Baumgartner, D. E. Elrick, and K. L. Bradshaw.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 469-483. 4 fig, 17 ref.

Descriptors: *Slowly-permeable materials, *Permeameters, *Measuring instruments, *Guelph Permeater, *Sampling devices, *Analytical methods, *Groundwater monitoring, Groundwater management, Hydraulic conductivity, Permeability coefficient, Soil water, Mathematical studies, Statistical methods, Design criteria, Design standards, Groundwater, Aeration zone.

Simultaneous, in-situ measurements in the unsaturated zone of the field-saturated hydraulic conductivity (HC) and the matric flux potential, (MDP) can be obtained using the Guelph Permeameter (GP). Simplifying assumptions lead to approximations of the sorptivity (S) and the 'alpha' parameter of an assumed exponential hydraulic conductivity - soil water pressure head relationship. The procedure involves measuring the steady-state rate of water intake or recharge, Q, from a cylindrical hole of radius 'a' in which a constant depth of water, H, is maintained. The GP employs a simple 'in-hole' Mariotte bottle technique to establish and maintain H, and to measure the corresponding Q. Two or more (H, Q) data pairs for each hole of radius 'a' can be substituted into the appropriate equations to obtain (HC), (MFP), S and alpha. The solutions are based on three-dimensional, saturated-unsaturated flow. The 'Guelph Infiltrometer' (GI) employs attachments to the permeameter that permit measurements at the surface, with very little disturbance of the soil surface itself. The analysis is very similar to the GP with the GI being a special case of the GP with H = O and with the GI sitting on the soil surface (i.e., a surface vs. a buried source). HC and MFP are

obtained using two or more (r, Q) data pairs where 'r' is the wetted surface of the disk attachment. For compacted material such as clay liners and for naturally slowly permeable soils, several modifications in instrument design and use are suggested which lead to more sensitivity in the measurements. (See also W88-08991) (Author's abstract)
W88-09018

APPLICATION OF GRAVITY AND SEISMIC METHODS IN HYDROGEOLOGICAL MAPPING AT A LANDFILL SITE IN ONTARIO,
Ontario Ministry of the Environment, Toronto.
E. B. Rodrigues.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 487-504. 6 fig, 1 tab, 8 ref.

Descriptors: *Geophysics, *Mapping, *Seismic waves, *Landfills, *Geohydrology, *Groundwater monitoring, *Analytical methods, *Measuring instruments, *Sampling devices, Path of pollutants, Water pollution sources, Solute transport, Monitoring wells, Surveys, Groundwater, Ontario, Organic compounds, Groundwater management, Groundwater pollution, Monitoring.

An extensive hydrogeological investigation was undertaken near the town of Bracebridge, Ontario, following the discovery of trichloroethylene in the municipal water supply. The town is served by water wells which are located about 1 km south of a landfill site to the wells. The site is located within glacial sand and gravel deposits which lie on Precambrian bedrock of granitic composition. The large contrast in density between overburden and bedrock provided ideal conditions for bedrock mapping by the gravity method. A well-defined buried bedrock channel was detected by this technique. The bedrock channel could provide a possible pathway for migration of pollutants from the landfill site. The gravity survey was supplemented by seismic refraction in order to obtain a better three-dimensional definition of the channel. The combined used of gravity and seismic methods allowed the investigation to be completed in a cost-effective manner. Following the geophysical survey, monitoring wells were installed along the axis of the channel. (See also W88-08991) (Author's abstract)
W88-09019

APPLICATION OF SEISMIC REFRACTION AND TERRAIN CONDUCTIVITY METHODS AT A GROUND WATER POLLUTION SITE IN NORTH-CENTRAL NEW JERSEY,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
D. W. Hall, and D. L. Pasicznyk.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 505-524. 11 fig, 6 ref.

Descriptors: *Mapping, *Rock properties, *Seismic waves, *Groundwater monitoring, *Geophysics, *Geohydrology, *Groundwater pollution, Analytical methods, Groundwater measurements, Measuring instruments, Leaching, Data interpretation, Model studies, Mathematical studies, Path of pollutants, Water pollution sources, Groundwater, Hydraulic conductivity, New Jersey.

Seismic refraction profiling was used to delineate bedrock topography at a groundwater pollution site in Morris County, New Jersey. The seismic data were interpreted using a ray-tracing algorithm. The results of the refraction interpretation indicate that the bedrock surface forms a 'saddle' beneath the overburden. The distribution of contamination in several domestic wells west of the site indicates that the contaminant plume forms a narrow band in the western bedrock low. Thus, the source of the contaminant is interpreted to be west of and slightly downgradient from the topographic saddle. A terrain conductivity survey was undertaken to locate the possible leaching field or buried drums which could be the source of the contamination. The contoured data disclosed several small spatially high-frequency anomalies caused by metallic objects and a large spatially low-frequency anomaly of unknown origin. If the terrain conductivity data had been interpreted without comparison to the results of the seismic refraction survey, the large spatially low-frequency anomaly would have been interpreted as a conductive groundwater plume. An overburden-thickness map was constructed from the seismic interpretation and compared to the terrain conductivity map. There appears to be a correlation between the increase in thickness of overburden and high conductivity values. However, various explanations for this anomaly could be proposed: surface spillage of the contaminant which may have occurred during the removal of a waste-storage lagoon, concentration of contaminants near the source, thickening of the overburden, or pooling of the contaminant caused by shallow impermeable layers. The most plausible explanation is a combination of increased overburden thickness and increased contaminant concentration. (See also W88-08991) (Author's abstract)
W88-09020

OFF-END SURFACE SEISMIC REFLECTION SOUNDING WITH VERTICAL SEISMIC PROFILING IN GLACIAL TERRAIN,
Minnesota Dept. of Natural Resources, St. Paul. Div. of Waters.
A. Streitz.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 525-537. 9 fig, 6 ref.

Descriptors: *Glacial aquifers, *Vertical seismic profiling, *Aquifer characteristics, *Seismic waves, *Geophysics, *Geohydrology, Measuring instruments, Aquifers, Data interpretation, Model studies, Statistical methods, Groundwater, Minnesota, Analytical methods, Groundwater management, Correlation analysis.

Surface seismic geophysical results were compared against geologic and geophysical logs at a site near Belgrade, Minnesota. Targets of interest included aquifer boundaries within glacial deposits. Vertical seismic profiling (VSP) information also was gathered to clarify the reflection velocity analysis and judge the validity of the processing routines. Depths calculated for reflection arrivals from the surface seismic records correlated to within 4% of a 27 meter reflector and within 6% of a 73 meter reflector identified from well logs. The agreement of VSP-calculated velocities and the root-mean-squared velocities developed from the surface refraction-based velocity model was also of a high order, with a correlation of 97% between the two velocities for the 27 meter interface. Moreover, analysis of the entire waveform from several of the VSP records revealed reflections from two unit boundaries that correspond with the dominant reflectors isolated from the surface seismic records. This study provides a reference point for further surface shallow seismic reflection work in glacial terrain and reinforces the interpretation of the authors previous investigations in other parts of Minnesota. (See also W88-08991) (Author's abstract)
W88-09021

MONITORING COASTAL WATERS ENVIRONMENTAL QUALITY: THE U.S. NATIONAL STATUS AND TRENDS PROGRAM,
A. Robertson.
IN: Status of the Nation's Water Quality Information Activities. Proceedings of a meeting held May 19-21, 1987, Charlottesville, VA. 1987. p 14-28, 4 fig, 4 tab, 9 ref.

Descriptors: *Coastal waters, *Water quality, *Monitoring, *Hydrologic data collections, Water quality management, Water pollution prevention, Water pollution effects, Benthos, Sampling, Mussels, Fish, Marine animals, Marine sediments, Chlorinated hydrocarbons, Pollutant identification, Polychlorinated biphenyls, Trace elements, Heavy metals, National Status and Trends Program, Tissue analysis, Water pollution.

The National Status and Trends (NST) Program of the National Oceanic and Atmospheric Administration was initiated to make systematic observations in carefully selected locations using meaningful indicators of coastal marine environmental conditions in order to detect changes in environmental quality. The NST Program is composed of six components: Benthic Surveillance, Mussel Watch, Specimen Bank, Methods Test and Evaluation, Historical Trend Assessment, and Quality Assurance. The first two of these provide actual measurements of concentrations of toxic chemicals in marine organisms and sediments and biological parameters that reflect anthropogenic stress. The other four components are complementary, supporting projects to help improve and interpret the monitoring measurements. The Benthic Surveillance Project measures the concentrations of a large number of chlorinated synthetic organic compounds, polycyclic aromatic hydrocarbon compounds, and trace elements in bottom fish and in surficial sediments taken from the same sites. The same potentially toxic chemicals are measured in bivalves in the Mussel Watch Project. Preliminary results from the Benthic Surveillance sampling in 1984 revealed that polychlorinated biphenyl (PCBs) levels are greater near large cities, the natural variability of certain contaminants should be taken into consideration, and relatively high levels of fish disorders are associated with areas having high levels of PCBs, lead, and other contaminants. (See also W88-09039) (Geiger-PTT)
W88-09041

WATER QUALITY INFORMATION ACTIVITIES OF THE SOIL CONSERVATION SERVICE,
G. L. Stem.
IN: Status of the Nation's Water Quality Information Activities. Proceedings of a meeting held May 19-21, 1987, Charlottesville, VA. 1987. p 37-40.

Descriptors: *Soil Conservation Service, *Networks, *Water quality, *Interagency cooperation, *Hydrologic data collections, Groundwater management, Pesticides, Water management, Water pollution prevention, Network design, Water quality management, Great Lakes, Chesapeake Bay, Performance evaluation.

A brief overview of water quality activities in the Soil Conservation Service (SCS) is given. The U. S. Department of Agriculture (USDA) and SCS have issued new policies on water quality which take into account pesticides and groundwater quality. The Water Quality Act of 1987 involves the USDA and SCS in the nonpoint source initiatives resulting from the Clean Water Act Amendments. The Food Security Act of 1985 will have major water quality implications for the Great Lakes, Chesapeake Bay, and other areas as the provisions are implemented. Three important aspects of water quality data collection are discussed: use and analysis, interagency coordination, and network analysis in water-quality data collection. SCS provides land-based information such as land use; land treatment; and land treatment impacts on erosion, sediment delivery rates, and other similar information. There is a need for, and an interest in, interagency coordination among federal, state, and local agencies. Network analysis consists of assessment of the efficacy of a water quality network or an analysis of a water-quality data collection network. Network analysis is an important process which should be used in water quality data collection activities. (See also W88-09039) (Geiger-PTT)
W88-09043

WATER QUALITY INFORMATION ACTIVITIES OF THE GEOLOGICAL SURVEY,
D. A. Rickert.
IN: Status of the Nation's Water Quality Information Activities. Proceedings of a meeting held May 19-21, 1987, Charlottesville, VA. 1987. p 45-56.

Descriptors: *Monitoring, *Geological Survey, *Networks, *Hydrologic data collections, Acid rain, Groundwater management, Fate of pollutants, Sediment transport, Water quality, Nonpoint pollution sources, Monitoring, Sediment load,

Lead, Nitrates, Groundwater pollution, Water quality management, Heavy metals, Urban areas.

The water quality information activities of the U. S. Geological Survey (USGS) involve national networks of sites where data are collected from surface or ground waters. The National Stream Quality Accounting Network (NASQAN) provides a consistent description of the quality of the Nation's surface water and determines whether water quality is deteriorating, unchanging, or improving. The National Hydrologic Bench-Mark Network defines the natural water quality of streams in basins where the land surface has not been altered by man. Concentrations of dissolved lead decreased significantly at a number of NASQAN stations from 1975 to 1985. Increases in nitrate were widespread during 1975 to 1985, and were attributed to an increase in the use of nitrogen fertilizers and in atmospheric deposition of nitrogen. Levels of sulfates at NASQAN stations in general, decreased in the Northeast and increased throughout most of the rest of the nation. The USGS started formally collecting and publishing daily sediment data on a routine basis in the early 1940's. The USGS as lead agency for deposition monitoring in the National Acid Precipitation Assessment Program, is responsible for managing the National Trends Network (NTN). NTN collects samples weekly at 150 stations and monitors them for precipitation amount, specific conductance, pH, and various elements and compounds. The USGS also conducts a Toxic Substances Hydrology Program, a Nonpoint-Source Groundwater Studies Program, and an Urban Water Quality program. Other water quality activities of the USGS include the National Water Quality Assessment and numerous studies currently conducted in cooperation with State and other local agencies. (See also W88-09039) (Geiger-PTT)
W88-09044

GROUND-WATER DATA REQUIREMENTS ANALYSIS FOR THE ENVIRONMENTAL PROTECTION AGENCY.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-228540. Price codes: A04 in paper copy, A01 in microfiche. Contract No. GS-00K-85AFD-2777, Task No. W6800-035. May 1987. 75 p, 1 fig, 23 exhibits.

Descriptors: *Project planning, *Data requirements, *Data collections, *Data acquisition, *Hydrologic data, *Hydrologic data collections, *Monitoring, Decision making, Management planning, Research priorities, Data interpretation, Evaluation, Data storage and retrieval, Network design, Grounwater management, Water management, Decision making, Management planning, Information exchange.

The Office of Groundwater Protection and the Office of Information Resources Management are jointly conducting an analysis of information needs of the U. S. Environmental Protection Agency's (EPA) groundwater data management requirements. This study defines a management framework and data utility that the EPA and states can use to store, share, and manipulate groundwater data to support better environmental decision-making, and to identify specific initiatives by which this framework can be implemented. Groundwater data management is growing more important and complex. Decision makers need improved capabilities in data access, data retrieval, and data analysis. Several alternative scenarios were identified for improving groundwater data management. In reviewing these options, the EPA and the Groundwater Data Requirements Analysis Policy Committee reached a consensus on several topics: investments in improved groundwater data management are necessary and justified, although improvements should be phased in over time to limit risk and minimize disruption; existing and proposed projects for improving groundwater data management must be carefully coordinated and managed to maximize their pay-off; new groundwater data standards and practices must be voluntarily adopted by states, EPA Regions, and EPA program offices. It is recommended that EPA compliment its current efforts by pursuing the following additional initiatives: establish a groundwater data standards work group; develop standard record formats; improve STORET to store new water quality data; and hold data management conferences, presentations, and workshops. (Geiger-PTT)
W88-09045

METHODOLOGY FOR ASSESSING UNCONTROLLED SITE PROBLEMS AT THE COUNTY LEVEL,
State Univ. of New York Coll. at Geneseo. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5E.
W88-09061

MONITORING TO SUPPORT RISK ASSESSMENTS AT HAZARDOUS WASTE SITES,
Environmental Monitoring Systems Lab., Las Vegas, NV.
G. E. Schweitzer.
IN: Risk Assessment at Hazardous Waste Sites. American Chemical Society, Washington, DC. 1982. p 73-91, 10 fig, 2 ref.

Descriptors: *Hazardous wastes, *Waste dumps, *Monitoring, *Risks, *Chemical analysis, *Water analysis, *Data acquisition, *Pollutant identification, Feasibility studies, Cost analysis, Mass spectrometry, Geophysics, Waste disposal, Land disposal, Water pollution effects, Environmental impact statement, Bioaccumulation, Remote sensing.

The classical approaches to multimedia monitoring at hazardous waste sites are briefly reviewed, with examples from recent site investigations. The types of monitoring data that are most useful in risk assessments are discussed in terms of feasibility, costs, and time for acquisition. Required emphases for assessing hazardous dump sites and for determining long-term habitability of a larger area are described. Special attention is directed to geophysical techniques, biological monitoring, and providing more meaningful monitoring data for health assessments. The most commonly used geophysical techniques are seismic refraction, ground penetrating radar, electrical conductivity, and magnetometer surveys. Efforts have also been initiated to instrument new sites with electrode systems for detecting leachate leakage through the liners of the sites. Another promising approach calls for combining laser-induced fluorescence to indicate pollutant contamination of an aqueous body, and in this case groundwater, with fiber optic techniques for entering the earth through very small diameter wells. A number of advanced methods for analyzing environmental samples in the laboratory are under investigation. Of particular relevance to the problems of hazardous wastes are the application of fused silica capillary columns in gas chromatography/mass spectrometry systems, Fourier transform infrared spectroscopy, and non-extractive multi-elemental analysis. Triple quadrupole mass spectrometry can provide rapid screening of complex mixtures for specific compounds. The types of biological methods that need to be carefully evaluated and, if appropriate, standardized for field use include laboratory screening tests, field survey methods, and monitoring techniques to detect specific compounds in biological materials. (See also W88-09056) (Geiger-PTT)
W88-09062

MONITOR WELL INSTALLATION AT K-1407-B AND K-1407-C SURFACE IMPOUNDMENTS AT THE OAK RIDGE GASEOUS DIFFUSION PLANT,
Geraghty and Miller, Inc., Oak Ridge, TN.
D. B. Klos, and P. R. Gardner.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-011802. Price codes: A03 in paper copy, A01 in microfiche. March 1986. 7 p, 1 fig, 1 tab, 1 ref, 2 append.

Descriptors: *Test wells, *Groundwater management, *Boreholes, *Monitoring, *Monitoring wells, *Wastewater pollution, *Settling basins, Aquifers, Geohydrology, Drilling, Groundwater pollution, Screened wells, Settling basins, Wastewater facilities, Oak Ridge Gaseous Diffusion Plant, Tennessee.

In October 1985, Geraghty and Miller, Inc. was retained by Martin Marietta Energy Systems, Inc. to design and install monitor wells in the uppermost aquifer, in the vicinity of two surface impoundments, in accordance with EPA regulations for interim status. The two impoundments, K-1407-B and K-1407-C, are within the confines of the Oak Ridge Gaseous Diffusion Plant. K-1407-B receives pH-neutralized discharge and is a settling pond for precipitates from neutralized metals, cleaning solutions, uranium decontamination solutions, and neutralized coal-pile runoff. K-1407-C is a settling pond for precipitates from mixed corrosive and non-hazardous waste. Eleven screened wells were installed in the upper aquifer in the vicinity of the two impoundments. The details of well construction are described, and the geologic and hydrologic observations made during the drilling are summarized. Hydrogeologic observations from the test wells showed that the uppermost aquifer in the vicinity of the impoundments is comprised of unconsolidated weathered residuum of the underlying rock. Permeability of the uppermost aquifer is relatively low. This, in conjunction with the subdued topography of the area, suggests a slow rate of groundwater flow, probably in the range of feet per year. (Geiger-PTT)
W88-09086

HAZARDOUS WASTE: QUESTIONS AND ISSUES FROM THE FIELD,
Environmental Protection Agency, Boston, MA. Region I.
For primary bibliographic entry see Field 5E.
W88-09121

USES OF ENVIRONMENTAL TESTING IN HUMAN HEALTH RISK ASSESSMENT,
Centers for Disease Control, Atlanta, GA.
C. W. Heath.
IN: Environmental Sampling for Hazardous Wastes. American Chemical Society, Washington, DC. 1984. p 7-13, 1 tab, 6 ref.

Descriptors: *Environmental testing, *Human diseases, *Risks, *Public health, *Risk assessment, *Waste disposal, *Environmental effects, Data interpretation, Pollutants, Population exposure, Toxicity, Physical properties, Chemical properties, Path of pollutants, Fate of pollutants, Metabolism, Love Canal, New York.

The process of assessing environmental health risks is detailed. Factors contributing to the nature and degree of exposure are examined first. They include characteristics of the toxic material, environmental pathways, and mechanisms operating in absorption and metabolism in the host. The biologic effects resulting from such exposure are defined in relation to the amount of exposure, to humans and animal models. Information about exposure and biologic effect characteristics is interpreted in relation to predetermined definitions of biologic safety to establish acceptable risk levels. Once an acceptable 'safe' level of chemicals has been determined for particular environmental media on existing toxicologic and epidemiologic data and on appropriate safety model criteria, accurate, reproducible, and economically feasible programs for measurement of environmental chemicals must be implemented. Environmental testing procedures at the Love Canal in New York and the surrounding homesites were detailed. (See also W88-09120) (Wood-PTT)
W88-09122

ASSESSING CYANIDE CONTAMINATION FROM AN ALUMINUM SMELTER,
Washington State Dept. of Ecology, Olympia.
R. A. Burkhalter, T. J. Mix, M. F. McCall, and D. O. Provost.
IN: Environmental Sampling for Hazardous Wastes. American Chemical Society, Washington, DC. 1984. p 15-26, 9 fig, 15 ref.

Descriptors: *Water pollution sources, *Cyanide, *Path of pollutants, *Waste disposal, *Hazardous materials, Industrial wastes, Metal-finishing wastes, Aluminum smelters, Washington, Groundwater contamination, Aquifers, Monitoring, Water quality, Monitoring wells.

Cyanide contamination of the Spokane aquifer, Washington, was discovered in 1978 and attributed to an aluminum reduction facility located over the aquifer. During the aluminum production process cyanide is formed as a byproduct and adsorbed into the carbon cathode (potliner). When the potliner fails, usually after three years of operation, it was removed from the steel pot shell and deposited in an unprotected pile. Because of forthcoming state and federal regulations and problems revealed at other plants, the Company decided to drill test wells to determine if storage of waste materials at the plant site had resulted in environmental contamination and found high concentrations of cyanide (300 ppm) and fluoride in the wells drilled around the disposal site. Existing wells used for drinking water, irrigation and livestock purposes outside the plant boundary contained total cyanide concentrations as high as 23 ppm. Immediate remedial actions taken by the company did not result in significant changes in cyanide levels in the groundwater by mid-1980, so more monitoring wells were drilled to define the situation better. Geohydrological studies, sampling problems and analytical problems were detailed. The major technical problem was the inability to define subsurface geohydrologic conditions with the initial data. A lack of specific analytical techniques precluded meaningful environmental and risk assessments and the failure to include cyanide under the current drinking water standards or potliner waste under hazardous materials created confusion with regard to regulations. (See also W88-09120) (Wood-PTT)
W88-09123

STATISTICAL METHODS IN ENVIRONMENTAL SAMPLING,
Radian Corp., Austin, TX.
L. P. Provost.
IN: Environmental Sampling for Hazardous Wastes. American Chemical Society, Washington, DC. 1984. p 79-96, 5 fig, 3 tab, 11 ref.

Descriptors: *Statistical methods, *Environmental sampling, *Sampling, *Pollutant identification, *Data acquisition, *Network design, *Mathematical studies, Statistics, Statistical analysis, Statistical models, Mathematical equations.

The role played by statistics in environmental sampling, with emphasis on enumerative environmental sampling studies, is explored. An enumerative study provides a basis for action directed to the population from which the samples were taken; how or why the population was formed is not of primary interest. Examples of enumerative studies include testing of soil or wastes to define required cleanup, measuring emissions from process sources to identify those needing maintenance, and determining locations of air monitoring stations to monitor pollutant levels. The use of statistics is discussed for the various steps common to all environmental sampling studies including: statement of objectives; description of the study population; characteristics of the study population and methods of measurement of those characteristics; statement of the required precision of results; design of the sampling study; and conduct of the sampling study. Several examples of sampling models are presented. (See also W88-09120) (Wood-PTT)
W88-09125

QUALITY ASSURANCE FOR A MEASUREMENT PROGRAM,
National Bureau of Standards, Washington, DC.
J. K. Taylor.
IN: Environmental Sampling for Hazardous Wastes. American Chemical Society, Washington, DC. 1984. p 105-108, 7 ref.

Descriptors: *Measurement programs, *Monitoring, *Standards, *Data collection, *Quality control, Data quality control, Calibration, Design standards, Specifications.

Measurement data of adequate quality are necessary if environmental problems are to be properly understood and effective actions taken to correct them. The general features of quality assurance programs for all aspects of the measurement process, especially monitoring programs, are discussed. The analogy of monitoring operations to modern manufacturing operations involving a number of subcontractors or vendors of services is made and explained. The monitoring program should establish its own quality standards and specify minimum quality assurance practices that the vendor of services should follow. The monitoring program should also supply reference materials for the intercalibration of the vendors and maintain control charts to monitor intercalibration and to detect any deviations from proficient performance. Only experienced vendor laboratories, pre-qualified by objective testing procedures, should be used. Their maintenance of proficiency should be monitored throughout the program and their retention as vendors should be contingent on their ability to supply data of specified quality. Laboratories should not be paid for data of insufficient or undocumented quality. Monitoring program management must select and train candidates prior to their acceptance if an insufficient number of qualified vendors is not available. (See also W88-09120) (Wood-PTT)
W88-09126

NEW WAYS OF ASSESSING SPATIAL DISTRIBUTIONS OF POLLUTANTS,
Stanford Univ., CA. Aerosol Lab.
A. G. Journel.
IN: Environmental Sampling for Hazardous Wastes. American Chemical Society, Washington, DC. 1984. p 109-118, 3 fig, 10 ref.

Descriptors: *Network design, *Sampling, *Spatial distribution, *Probability distribution, *Data interpretations, Pollutants, Mathematical studies, Mathematical equations, Distribution, Statistical analysis, Conditional distribution, Decision making.

In order to characterize the spatial distribution of pollution, knowledge at each location x within the site of the probability distribution of the unknown concentration p(x) would be ideal. These distributions need to be conditional to the surrounding available information in terms of density, data configuration, and data values. Most traditional estimation techniques, including ordinary kriging, do not provide such probability distributions or 'likelihood' of the unknown values p(x). Use of these likelihood functions in the conditional distribution approach toward assessment of the spatial distribution of pollutants was presented and a non-parametric method for deriving these likelihood functions was proposed. In the conditional distribution approach, for each node x of a grid, the whole likelihood function of the unknown value p(x) is produced instead of a single estimated value. This likelihood function allowed derivation of different estimates corresponding to different estimation criteria (loss functions), and provided data values-dependent confidence intervals. The likelihood function can also be used to assess the risks associated with the decisions to clean or not. (See also W88-09120) (Wood-PTT)
W88-09127

DETECTING ELEVATED CONTAMINATION BY COMPARISONS WITH BACKGROUND,
National Bureau of Standards, Washington, DC.
W. Liggett.
IN: Environmental Sampling for Hazardous Wastes. American Chemical Society, Washington, DC. 1984. p 119-128, 1 tab, 16 ref.

Descriptors: *Pollutant identification, *Network design, *Soil contamination, *Statistical methods, *Baseline studies, *Data interpretation, Mathematical studies, Statistical models, Statistical analysis, Statistics, Mathematical equations, Comparison studies.

Studies on the detection of excess levels of a common soil contaminant must include the sampling and measurement of a background region so that detection can be based on comparison of the background measurements with measurements on the suspected region. The statistical model used to compare the measurements from two regions was detailed and the skew distribution found in background measurements that were obtained from soil samples was discussed. Studies based on comparison with background measurements that may have a skew distribution were presented and design of this type of study was discussed. The design was intended to insure that the model for the comparison was valid and that the amount of skewness was minimized. Subsequently, a statistical method for the comparison of the background measurements with the largest of the measurements from the suspected region was presented. The method, which was based on the use of power transformations to achieve normality, was original in that it took estimation of the transformation from the data into account. (See also W88-09120) (Wood-PTT)
W88-09128

PROCEEDINGS OF THE THIRD NATIONAL SYMPOSIUM ON AQUIFER RESTORATION AND GROUND-WATER MONITORING.
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 4B.
W88-09129

HYDROCARBON CONTAMINATION OF CARBONATE AQUIFERS: ASSESSMENT AND ABATEMENT,
P. M. Yaniga, and D. J. Demko.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 60-65, 9 fig.

Descriptors: *Groundwater pollution, *Cleanup operations, *Oil spills, *Water pollution control, *Water pollution treatment, *Case studies, *Oil recovery, Aquifer management, Technology, Assessments, Fuel, Oil, Carbonate rocks, Leakage, Field tests, Pipelines.

A groundwater contamination problem related to losses of fuel oils that went unaddressed and unattended for a two-year period is discussed. The techniques and methodologies undertaken that enabled the successful assessment and abatement of the problem is described. Impact of hydrocarbon loss is assessed, and field investigation, field testing results and data analysis are presented. Aquifer abatement methodology and product recovery program are also outlined. This case history shows that the deployment of technically sound means of pollution impact assessment, when coupled with 'hands on' experience, does lead to successful contamination abatement. The abatement/recovery operations initiated by Groundwater Technology in 1983 have successfully stopped and reversed migration of the fugitive fuel. This activity also protects nearby water wells from possible hydrocarbon contamination. The product retrieval operations were recovering 500 to 700 gallons/day of reusable fuel oil-type hydrocarbons. (See also W88-09129) (Friedmann-PTT)
W88-09137

EVALUATION OF GROUND-WATER CONTAMINATION ASSOCIATED WITH THE USE OF ORGANIC SOLVENTS AT ROMANSVILLE, PENNSYLVANIA,
P. Gruber.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 69-75, 2 tab, 5 fig.

Descriptors: *Groundwater pollution, *Organic compounds, *Water pollution treatment, *Trichloroethane, *Hydrologic data collections, *Cleanup operations, Remedies, Water quality control, Sampling, Leachates, Fracture permeability, Groundwater movement, Geohydrology, Pennsylvania, Monitoring.

This paper describes the hydrogeologic investigation, remedial activities and recommendations of a

consultant brought in by the Pennsylvania Dept. of Environmental Resources to check the occurrence of volatile organic chemicals in the groundwater in the vicinity of the Richard M. Armstrong (RMA) Co. plant near Romansville, Pennsylvania. The chemicals were directly related to the accidental and incidental release to the ground surface of small but unknown quantities of technical-grade trichloroethane used at this fabricating plant. As a result of an extensive groundwater quality sampling program, which included all homes directly surrounding the plant, as well as nearby homes on or near bedrock fracture traces intersecting the site, seven homes were identified as having total organic chemical concentrations greater than 100 ppb, in excess of state standards. A total of 58 wells was sampled for this study. For the remedial action program, contaminated soil surrounding the RMA plant was identified and removed. A new monitor/purge well was drilled to a depth of 348 feet near the highest contaminated soil area and at the intersection of several fracture traces. Water treated by a carbon filtration system was pumped at least once a week from this well. It was recommended that monitoring at and around the site be continued on a monthly basis. (See also W88-09129) (Friedmann-PTT)
W88-09138

WATER-QUALITY MONITORING AT HAZARDOUS WASTE DISPOSAL SITES: IS PUBLIC HEALTH PROTECTION POSSIBLE THROUGH MONITORING PROGRAMS,
Texas Tech Univ., Lubbock. Dept. of Civil Engineering.
G. F. Lee, and R. A. Jones.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 189-200, 1 fig, 1 tab, 9 ref.

Descriptors: *Legal aspects, *Regulations, *Groundwater pollution, *Land disposal, *Resource Conservation and Recovery Act, *Monitoring, *Administrative regulations, *Environmental protection, *Hazardous materials, Public health, Water quality management, Waste dumps, Chemical pollution, Pollution taxes.

This paper addresses some of the problems of the current EPA Resource Conservation and Recovery Act (RCRA) new-site groundwater quality monitoring programs in providing public health and environmental protection in association with hazardous waste disposal at RCRA-approved sites. The author concludes that the current EPA RCRA regulations governing the siting, operation, closure and post-closure of new hazardous waste disposal sites do not provide adequate provisions for long-term protection of public health and the environment for those living near or utilizing lands adjacent to hazardous waste disposal sites. One of the principal problems was the lack of provision for an adequate water-quality monitoring program for the groundwater near the sites. There was significant public health and environmental hazard associated with the burial of hazardous wastes containing components that tended to have a high mobility in groundwater systems and had significant potential toxicities below their analytical method detection limits. The author recommends that a tax-fee be placed on all hazardous wastes disposed of by land burial, the revenue from which would be used to support research devoted to improving analytical methods and aqueous environmental chemistry predictive capabilities for highly hazardous, high-mobility hazardous waste components. (See also W88-09129) (Friedmann-PTT)
W88-09151

DESIGN OF COST-EFFECTIVE CHEMICAL MONITORING PROGRAMS FOR LAND DISPOSAL FACILITIES,
J. H. Clarke, R. D. Mutch, and M. R. Brother.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 201-204, 5 fig.

Descriptors: *Groundwater pollution, *Monitoring, *Cost analysis, *Solute transport, *Chemical mobility, *Land disposal, *Water quality control, *Contamination, Data acquisition, Remedies, Path of pollutants, Plumes, Aquifer management, Risks, Gas chromatography, Hydrogen ion concentration, Project planning, Cost analysis, Organic compounds.

Chemical monitoring of groundwater quality, in the vicinity of land disposal facilities accomplishes a wide range of objectives, including detection of contamination, generation of data for risk assessment, and generation of data for remedial engineering. As the monitoring program proceeds through a logical phased approach, additional data can be developed to refine program design as needed for cost-effectiveness. For example, if the objective is definition of plume boundaries and extent, one should look for highly mobile waste constituents and indicators. Three potential monitoring parameters are standard water-quality indicators such as pH, total gas chromatographic (GC) scans such as total volatile organics (TVO), and analysis of specific waste consituents, such as chloride ion, trichloroethylene, or chlorobenzene. A useful classification scheme could run from Class I (most mobile, chloride ion) to Class IV (least mobile, moderate to high molecular weight organics such as polychlorinated biphenyls and chlorinated benzenes). The ability to predict and confirm relative chemical mobilities is essential to cost-effective selection of monitoring parameter selection and program design. (See also W88-09129) (Friedmann-PTT)
W88-09152

RATIONAL APPROACH TO THE DESIGN OF GROUND-WATER MONITORING SYSTEMS, USING BAYESIAN DECISION THEORY,
Holzmacher, McLendon and Murrell, Melville, NY.
P. W. Grosser, and A. S. Goodman.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 205-212, 3 fig, 6 tab, 8 ref.

Descriptors: *Groundwater pollution, *Aquifer management, *Monitoring, *Statistics, *Water quality control, *Decision making, Stochastic models, Project planning, Bayesian decision theory, New York, Long Island, Systems analysis.

This paper describes use of the Bayesian decision theory as an approach to groundwater monitoring system design. The Bayesian approach to decision theory differs from more classical statistical approaches in that it utilizes prior information and opinions or judgments of the analyst. An outline of such an approach to groundwater monitoring system design would include (1) definition of problem and goal-setting; (2) analysis of project, with collection of available information and definition of uncertainties of the information, (3) development of stochastic properties of state variables, (4) definition and identification of the available alternatives, including no action, (5) determination of the outcome of the various alternatives, (6) development of loss function for each alternative based on decision variables, and (7) calculating the expected values of the utility function. The authors conclude from the methodology and the example presented in this paper (a site on Long Island, New York) that Bayesian decision theory provides a flexible method to address the above considerations. (See also W88-09129) (Friedmann-PTT)
W88-09153

CHEMICAL PROBLEMS IN GROUND-WATER MONITORING PROGRAMS,
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
M. J. Barcelona.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 263-271, 4 tab, 45 ref.

Descriptors: *Chemical analysis, *Water analysis, *Quality control, *Monitoring, *Measuring instruments, *Geochemistry, *Errors, *Data acquisition, Groundwater management, Performance evaluation, Remedies, Chemical analysis, Water analysis, Construction, Well casings, Sampling, Hydraulic engineering, Design standards.

In environmental or geochemical measurements, determinate errors are those that are constant or systematic. They directly influence the accuracy of the sampled mean result as an estimated of the presumed true value. They contribute to inaccurate or biased results and may significantly distort the geochemical picture drawn from a water chemistry data set. This paper discusses some general recommendations for the control of determinate sources of error in chemical measurements of groundwater geochemistry. Included are examples of sampling and analytical pitfalls that should be avoided in efforts to obtain high-quality monitoring information. Recommendations cover well siting and construction, selection of appropriated materials for well casing, screen or sampling devices, identification of analytes of interest, sampling protocol, well development techniques and flushing prior to sampling. (See also W88-09129) (Friedmann-PTT)
W88-09161

DEALING WITH THE PROBLEM OF OBTAINING ACCURATE GROUND-WATER QUALITY ANALYTICAL RESULTS,
S. J. Keith, M. T. Frank, G. McCarty, and G. Mossman.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 272-283, 2 tab, 20 ref.

Descriptors: *Accuracy, *Monitoring, *Groundwater, *Precision, *Chemical analysis, *Water analysis, *Contracts, *Quality control, *Laboratories, *Data acquisition, Water quality, Errors, Reports, Geohydrology.

Approaches to obtaining accurate analytical data in laboratory studies of groundwater are discussed. The two issues confronting hydrologists are (1) the degree to which the data represents what is being monitored and (2) The accuracy of the data. During the data generation stage, the hydrologist can influence the quality of laboratory analytical data through: (1) selecting a laboratory that can provide the quality of data required by the monitoring program, (2) providing the chemist with information on the matrices of the submitted samples, (3) independently assessing the quality of the reported data through the use of a general method, in the case of major ion analyses, or a specific constituent method, and (4) developing a contract with the laboratory that specifies, among other things, acceptable accuracy and precision ranges. (See also W88-09129) (Friedmann-PTT)
W88-09162

INACCURATE WATER-QUALITY DATA IN GROUND-WATER STUDIES,
Western Water Consultants, Inc., Sheridan, WY.
J. Ahern, and J. J. Grabowski.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 284-290, 2 fig, 3 tab, 7 ref.

Descriptors: *Monitoring, *Accuracy, *Quality control, *Organic compounds, *Measuring instruments, *Errors, *Data acquisition, *Precision, Remedies, Water analysis, Chemical analysis, Water quality, Halogens, Phenol, Methylene chloride, Oil, Grease, Groundwater management.

Inaccurate water quality data were discovered on five ground-water projects involving organic contaminants 1982. The inaccurate data would have led to false conclusions about the type, degree and extent of groundwater contamination. In most cases, the inaccuracies were traced to problems with the standard analytical methods used by the commercial laboratories. This paper discusses sources of inaccurate data, reasons for inaccurate laboratory data and techniques available to avoid, detect and occasionally correct inaccurate water quality data in organic groundwater contamination studies. Also covered are the problems that have

been encountered with the analysis of total organic halogen (TOX), which led to perhaps the most serious case of inaccurate data in organically contaminated groundwater samples to date. Water quality data can be inaccurate because of the inexperience of the laboratory to deal with unusual samples, or the inaccuracy can result from the inability of standard analytical methods to handle the interferences in the organically enriched water samples. Data from phenol, TOX, methylene chloride, oil and grease and many other constituents have either been found to be inaccurate or subject to misinterpretation. The selection of the best qualified laboratory, careful investigations into the validity of critical water quality data and cautious treatment of the data because of their uncertainty are the best approaches toward dealing with possibly inaccurate water quality data. (See also W88-09129) (Friedmann-PTT)
W88-09163

USE OF GEOPHYSICAL TECHNIQUES TO DELINEATE GROUND-WATER CONTAMINATION,
D. H. Bruehl.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 295-300, 3 fig, 3 ref.

Descriptors: *Groundwater pollution, *Geophysics, Resistivity, Water table profiles, Seismic properties, Bedrock, Mapping, Surveys, Aquifer management, Gravity studies, Seismology, Case studies, New Jersey, New Hampshire, Geology, Remote sensing Landfills, Industrial waste, Industrial plants, Municipal waste.

Geophysical techniques can be an aid in the delineation of ground-water contamination. This paper examines three short case histories in which such techniques were employed (an industrial site in New Jersey, an industrial disposal site in New Hampshire, and Hudson Municipal Landfill, New Hampshire). Care must be taken to select an appropriate technique for existing geologic conditions. Under the right conditions, electrical resistivity depth soundings can be used to detect and delineate areas of contaminated ground water. Seismic refraction is often effective for measuring the depth of the water table and depth of bedrock. Gravity surveys are useful for mapping the configuration of the buried bedrock surface. A number of other geophysical techniques are available and useful in many specific situations. (See also W88-09129) (Friedmann-PTT)
W88-09164

REFINEMENT OF THE SHALLOW SEISMIC REFLECTION TECHNIQUE IN DETERMINING SUBSURFACE ALLUVIAL STRATIGRAPHY,
Ecology and Environment, Inc., Kansas City, KS.
For primary bibliographic entry see Field 7B.
W88-09165

APPLICATION OF GEOPHYSICAL TECHNIQUES AS A SITE SCREENING PROCEDURE AT HAZARDOUS WASTE SITES,
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 7B.
W88-09166

APPROACH TO DRILLING AND INSTALLATION OF GROUND-WATER MONITORING WELLS ON HAZARDOUS WASTE SITES,
C. L. Hagger, and A. M. C. Desmarais.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 315-323, 1 fig.

Descriptors: *Safety, *Construction methods, *Installation, *Drilling, *Construction, *Monitoring, *Wells, Groundwater management, Land use, Well hydraulics, Cost analysis, On-site data collections, Hazardous materials.

This paper covers ground-water well construction specifications and safety procedures and is based upon the author's prior experience as employees of an EPA contractor responsible for the drilling and installation of ground-water monitoring wells in areas contaminated by hazardous waste. Chemical as well as major weather-related site hazards are covered, as well as proper use of protective equipment and safe drilling management. Drilling and installation of ground-water monitoring wells on hazardous waste sites requires well-defined construction specifications based on background data gathering of site characteristics, including past and present land uses, waste characterization, site topography, site mapping, site hydrogeology and health risk assessment information. This background data gathering should be conducted in order to determine the most cost-effective and safe design of a proposed ground-water monitoring well network. The authors recommend that a strong emphasis be placed on driller safety, including a health risk assessment, safety precautions and planning, health and safety training, medical screening, proper use of protective equipment and proper equipment decontamination procedures. (See also W88-09129) (Friedmann-PTT)
W88-09167

GROUND-WATER MONITORING IN CLAY-RICH STRATA - TECHNIQUES, DIFFICULTIES AND POTENTIAL SOLUTIONS,
Becon Construction Co., Houston TX. Mining Services Group.
C. R. Pollock, G. A. Robbins, and C. C. Mathewson.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 347-354, 8 fig, 2 tab, 7 ref.

Descriptors: *Water pollution sources, *Well fields, *Aquifer characteristics, *Network designs, *Groundwater pollution, *Monitoring, *Water quality, *Clays, Well yield, Hydraulic properties, Sampling, Pump wells, Groundwater recharge, Mapping, Chemical analysis, Anisotropy.

This paper emphasizes the inherent difficulties in characterizing in situ groundwater quality and detecting contaminants in clay-rich strata, and it proposes methods for their resolution. Groundwater conditions in clay-rich strata can present serious monitoring problems. Low well yields and anisotropic hydraulic properties can complicate pumping tests and water quality sampling. The use of submersible pumps is advisable for water quality sampling, but low withdrawal rates should be anticipated. The quality of in situ ground water may vary substantially and systematically in both a lateral and horizontal direction. In order to effectively monitor contaminant sources in clay-rich strata, an intensive well sampling program should be used to define the areal distribution of ground-water quality. In addition to locating monitoring wells close to a potential contaminant source, a few more wells should be spaced in a wiser grid that has been sited with respect to local recharge and discharge zones. This well grid will permit mapping of areal patterns of chemical quality in the in situ ground water and enhance the detection of contaminants. Additional insight can be gained by analyzing chemical trends in the in situ ground water and comparing them to regional ground water trends. The well volume approach to sample collection should generally be avoided in view of the characteristically low yields of clayey strata. However, a sampling procedure that is based on the measurement of selected parameters at the well discharge prior to sample collection should produce representative samples. (See also W88-09129) (Friedmann-PTT)
W88-09170

MONITORING AND MATHEMATICAL MODELING OF CONTAMINATED GROUND-WATER PLUMES IN PALEOFLUVIAL ENVIRONMENTS FOR REGULATORY PURPOSES,
J. L. Osiensky, G. V. Winter, and R. E. Williams.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 355-355-364, 9 fig, 1 tab, 8 ref.

Descriptors: *Network design, *Well fields, *Mathematical modeling, *Monitoring, *Path of pollutants, *Groundwater pollution, *Plumes, *Fluvial sediments, Silt, Sand, Clay, Subterranean streams, Resistivity, Surveying, Deposition, Case studies, Palehydrology, Random walk models.

The major contributing factor to the complexity of designing groundwater monitoring systems in fluvial deposits is that the sediments consist generally of interbedded layers of sand, silt and clay, with lenses of coarse sand or gravel (buried stream channel deposits). In this paper, the authors utilize a two-dimensional, finite difference 'random walk' solute transport model of Prickett and others to simulate the migration of a conservative tracer in several hypothetical hydrostratigraphic settings. The purpose of the model is to illustrate the characteristics of contaminant migration through an aquifer with a single, fully penetrating stream channel. The results of the modeling and the case history discussed show that contaminants may migrate preferentially around monitor wells located immediately downgradient of the contaminant source. Awareness on the part of investigating hydrogeologists as to the existence of buried stream channels is critical to optimal monitor well field design and correct interpretation of the resulting water-quality data. Surface geophysical methods (primarily resistivity) may assist in the delineation of such channels if contamination already exists. If appropriate hydrogeologic conditions exist as a contaminated site, a resistivity survey may delineate plumes sufficiently that monitor well fields can be designed on the basis os the survey results. (See also W88-09129) (Friedmann-PTT)
W88-09171

FIELD APPLICATIONS OF CHEMICAL TIME-SERIES SAMPLING,
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
For primary bibliographic entry see Field 7B.
W88-09173

CORRELATION OF GEOPHYSICAL AND ORGANIC VAPOR ANALYZER DATA OVER A CONDUCTIVE PLUME CONTAINING VOLATILE ORGANICS,
Technos, Inc., Miami, FL.
R. Glaccum, M. Noel, R. Evans, and L. McMillion.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 421-427, 7 fig.

Descriptors: *Resistivity, *Electrical Studies, *Groundwater pollution, *Monitoring, *Organic compounds, *Path of pollutants, *Geophysics, *Plumes, Hydrocarbons, Conductivity, Chemical analysis, Permeability, Alluvial rivers, Benzene.

This paper reports on a portion of a study to evaluate two surface geophysical techniques, electromagnetics (EM) and resistivity, over a known contaminant plume. Because of the high organic content of the plume, a portable organic vapor analyzer (OVA) was employed in the field to provide semi-quantitative measurements of hydrocarbon concentrations for rapid verification and correlation to the geophysical results. The geophysical profile data revealed that a highly conductive ground-water plume of about 500 meters width had migrated over 1.5 miles downgradient form its source, apparently along alluvial channels of very permeable gravel and sand. OVA/gas chromatography determinations showed that benzene was present and suggested that the hydrocarbon component had followed very closely the electrolyte-rich ground-water component. The greatest hydrocarbon concentrations were measured at the greatest conductivity values and were detected as far as the extreme edges of the conductive plume. Using these results, additional surveys and monitoring well were being installed to provide a more detailed spatial representation and

chemical analysis of the system. (See also W88-09129) (Friedmann-PTT)
W88-09178

TWO CASE HISTORIES ON THE DESIGN AND PUMP TESTING OF INDIVIDUAL AQUIFERS WITH DUAL COMPLETED WELLS,
Blatchley Associates, Inc., Denver, CO.
J. L. Jehn.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 428-433, 10 fig.

Descriptors: *Test wells, *Packer pump, *Aquifer management, *Well hydraulics, *Pumping tests, *Monitoring, Case studies, Boreholes, Aquifer testing.

These two case histories describe the testing of individual aquifers with dual-completed wells and the utilization of a packer-pump system that allowed the isolation and monitoring of the aquifer not being pumped. While these two case histories are similar in the sense that multiple aquifers were individually tested with a packer-pump system in dual-completed wells, they are dissimilar because the first case study involved the testing from existing exploration holes while the second case study included the design of the test wells and observation hole clusters for that specific testing program. The comparison of the two case histories indicates that the pneumatic packer-pump system appears to be extremely flexible and adaptable to both open small-diameter, exploration-type holes not specifically designed for individual aquifer testing and also to wells more specifically designed for that type of testing. One of the drawbacks in multiple aquifer testing is that unless the individual aquifers are fairly similar in their capabilities (within a specified range of yield), more than one size of pump will have to be provided and adapted to the pneumatic packer system. It was felt, however, that this system can be adapted to multiple aquifer situations where more than two aquifers exist and a string of pneumatic packers separating and monitoring of all individual aquifers can be achieved. (See also W88-09129) (Friedmann-PTT)
W88-09179

UNIFORM METHODS FOR EXPOSURE REGIMES IN AQUATIC TOXICOLOGY EXPERIMENTS WITH CHEMICALLY DISPERSED OILS,
Department of the Environment, Ottawa (Ontario).
For primary bibliographic entry see Field 5C.
W88-09186

TECHNICAL ENFORCEMENT GUIDANCE DOCUMENT FOR GROUND-WATER MONITORING SYSTEMS,
Environmental Protection Agency, Washington, DC. Office of Waste Programs Enforcement.
For primary bibliographic entry see Field 6E.
W88-09284

INSTALLATION OF MULTI-LEVEL MONITORING WELLS IN A FRACTURED ROCK MEDIA,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
M. N. Gallagher, A. Leitzinger, and K. McIntosh.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 27-40. 8 fig, 1 tab, 15 ref.

Descriptors: *Monitoring, *Network design, *Drilling, *Lockport Formation, *Monitoring wells, *Groundwater monitoring, Aquifers, Permeability coefficient, Hydraulic conductivity, Statistical methods, Data interpretation, Groundwater, Aquifer characteristics, New York, Bedrock, Simulation, Grouting.

Drilling procedures were developed for the installation of clustered monitoring wells in a multi-layered fractured rock aquifer to identify and isolate the primary water-bearing fractures. The program included the installation of over 150 wells in the Lockport Formation, Niagara Falls, New York. This program includes rock coring, reaming, grouting of double well casings, hydrotesting, packer testing, and well development. The bedrock is composed of 150 feet of dolomite which has seven water-bearing fractures. Monitoring wells are cored sequentially from shallowest to deepest. Grouted-in-place carbon steel casings are used to isolate each water-bearing zone and prevent cross-contamination. Grout seals are composed of a mixture of cement/bentonite and set-time accelerator in a mixture which provides sufficient compressive strength and shrinkage properties. Grout seals are hydrotested to a permeability of 0.00001 cm/sec. Water-bearing fractures are identified by drill water loss, visual core observations or single packer test. Wells with a permeability of less than 0.0001 cm/sec are not considered water-bearing. Well clusters require approximately 30 days to complete and to 25,000 gallons of drill water is lost. Well development included pumping until clear or until three wells volumes were removed, whichever was greater. Simulating well development using Random-Walk indicates that after waiting 7 days after well cluster completion, all drilling fluid is beyond the influence of the well during development. Based on 8 quarters of chemistry and water level data, these drilling procedures have effectively identified and isolated the water-bearing zones in the bedrock. Inconsistencies related to drilling have been identified in the database. Wells with inconsistencies have been removed from the monitoring program. Additional protocols being investigated include grout bond determination and long-term maintenance. (See also W88-09283) (Author's abstract)
W88-09286

ARE HUMID AREA MONITORING CONCEPTS APPLICABLE TO ARID LANDS,
Schmidt (Kenneth D.), Fresno, CA.
K. D. Schmidt.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 41-50. 7 ref.

Descriptors: *Arid lands, *Monitoring wells, *Groundwater monitoring, *Groundwater pollution, *Monitoring, Groundwater recharge, Aquifer characteristics, Irrigation-return flow, Confining beds, Groundwater management, Seasonal variation, Aquifers, Rainfall, Groundwater, Standards.

Many of the guidelines for monitoring groundwater quality have been developed based on experiences in humid areas of the eastern U.S. Attempts are now being made to apply many of these guidelines at a number of sites in the southwest. Many pollution sites in the southwest are underlain by alluvial aquifers in arid settings. Commonly, the alluvium is thousands of feet thick. Depth to water often exceeds one hundred feet, and there are large seasonal and long-term water-level fluctuations. Precipitation often averages less than twelve inches per year, and there is usually a lack of direct recharge from this source. Instead, most recharge is associated with man's activities, such as irrigation. The layered nature of the alluvium plays a key part in pollutant movement. Coarse-grained alluvial strata, particularly stream channel deposits, frequently serve as conduits for the relatively rapid transport of pollutants through the aquifer. Plumes in the southwest are often large, comprising thousands or tens of thousands of acre-feet of water. This complicates monitoring because of the large volume of groundwater that must be defined. The relatively great depth to water in arid lands mandates the use of certain drilling and sampling methods. In addition, the large water-level fluctuations make it difficult to monitor the groundwater near the water table. Fine-grained strata often act as confining beds between the permeable strata, and vertical permeability becomes a key factor in evaluating the threat of a source to deeper public-supply wells. A substantial amount of experience has been gained at hundreds of monitoring sites in arid lands in recent years. This experience indicates that many of the guidelines proposed by humid area investigators are inapplicable at many sites in the arid southwest. (See also W88-09283) (Author's abstract)
W88-09287

EVOLUTION AND ADEQUACY OF GROUND WATER MONITORING NETWORKS AT HAZARDOUS WASTE DISPOSAL FACILITIES IN ILLINOIS,
Illinois State Geological Survey Div., Champaign.
B. L. Herzog, B. R. Hensel, E. Mehnert, J. R. Miller, and T. M. Johnson.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 98-119. 10 fig, append.

Descriptors: *Hazardous wastes, *Landfills, *Waste disposal, *Monitoring wells, *Network design, *Groundwater monitoring, Design criteria, Groundwater management, Geohydrology, Geophysics, Model studies, Illinois, Tanks, Optimization, Land application, Aquifers, Hydrology, Groundwater.

A study was recently conducted of ten hazardous-waste facilities in Illinois to determine the evolution and current adequacy of their monitoring networks. The facilities included landfills, surface impoundments, land application sites, and underground tank storage facilities. The study disclosed that the original design for the monitoring network at each of the ten sites was inadequate. In one case, a large landfill, the network consisted of only three monitoring wells, all of which later proved to be upgradient of the facility and, in addition, were finished in shallow sand lenses that were typically dry. Over the years, monitoring networks at each facility have improved to the point where most monitoring wells now appear to be located in the correct geologic units corresponding to the most probable flow path for contaminants. Several monitoring wells from earlier network designs have had to be replaced at some sites due to improper location or well construction techniques. Although the monitoring systems at these sites have all been refined within the past three years, only one of the facilities used geophysical techniques, and only two used computer models to aid in the design of their groundwater monitoring networks. Several recommendations have resulted from this study: (1) thorough hydrogeologic studies are necessary before an adequate monitoring program can be established, (2) the design of a monitoring network should not be determined a priori, rather it should reflect information gathered in hydrogelogic studies as well as any changes that may occur during the life of the facility, (3) regulations for the design of groundwater monitoring programs should allow for each site to be considered individually, and (4) additional techniques, such as groundwater modeling and geophysical methods, should be used where possible to assist in network design. (See also W88-09283) (Author's abstract)
W88-09292

DESIGN OF A MONITORING NETWORK TO DETECT THE EFFECTS OF LAND USE ON GROUND WATER QUALITY AND DESCRIBE THE CONTAMINANT FLOW SYSTEM IN THE PIEDMONT OF NORTH CAROLINA,
Geological Survey, Raleigh, NC. Water Resources Div.
D. A. Harned.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 120-137. 4 fig, 14 ref.

Descriptors: *North Carolina, *Piedmont, *Monitoring wells, *Network design, *Groundwater monitoring, *Path of pollutants, *Water quality, *Geohydrology, Hydrology, Aquifers, Groundwater management, Solute transport, Design criteria, Geologic fractures, Regolith, Land use, Streams, Groundwater.

The U.S. Geological Survey is investigating the relation of groundwater quality and land use in the combined regolith and fractured rock groundwater system of the North Carolina Piedmont. The study provides a description of the flow system, review of available data, and hypothesis formulation used to determine a water-quality monitoring network design for detailed study of selected areas. There are two principal hypotheses to be tested during the study: (1) the amount and type of groundwater contamination in the system can be related to land use, and (2) the transition zone between bedrock and regolith, when present, serves as a primary transmitter of groundwater and dissolved contaminants. The water-quality monitoring network design covers basins with five land uses in North Carolina. Monitoring of basins containing old industrial, new industrial, downtown urban, residential in Mecklenburg County, and agricultural land uses in Guilford County, will help define the relation of groundwater quality to land use. Water samples will be collected from a network of wells augered into the top of the saturated zone. Sampling wells open to different depths in the regolith and fractured rock system will help test the hypothesis that the transition zone is a primary transmitter of contaminated groundwater. Sampling of streams during base flow will accompany sampling of wells. (See also W88-09283) (Author's abstract)
W88-09293

USE OF PRESSURE DIFFERENTIAL MEASUREMENTS TO MAP CHEMICAL-QUALITY VARIATIONS IN A VARIABLE-DENSITY GROUND WATER SYSTEM,
Kansas State Geological Survey, Lawrence.
P. A. Macfarlane, M. W. Kemblowski, G. V. Costanzo, and J. Sadeghipour.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 138-150. 11 fig, 15 ref. U.S. Department of the Interior, Bureau of Reclamation, Office of Water Research Agreement 14-08-8001-G-1066.

Descriptors: *Differential pressure measurement, *Analytical methods, *Path of pollutants, *Groundwater pollution, *Saline water intrusion, *Surface-groundwater relations, *Saline-freshwater interfaces, *Geohydrology, Hydrology, Aquifers, Hydrodynamics, Monitoring wells, Solute transport, Groundwater, Spatial distribution, Temporal distribution, Water quality.

Frequent monitoring of saltwater intrusion areas is required to manage the extent of contamination. Differential pressure measurements in continuously screened wells can be used to map spatial and temporal groundwater chemical-quality variations in these affected stream/aquifer systems and to complement other hydrologic data such as streamflow, groundwater levels, and bottom-hole pressures. This technique is being used to monitor saltwater intrusion in a stream/aquifer system in central Kansas. Fresh and saline groundwaters are separated by a sharp interface or transition zone depending on the local hydrodynamic conditions. The position of the sharp interface or transition zone varies with river stage. Groundwater sample densities range from 67.58 lb/cu ft (1.083 gm/cu cm; which is equivalent to 120,000 ppm TDS) to 62.37 lb/cu ft (1.000 gm/cu cm; which is equivalent to less than 600 ppm TDS). Pressure differentials are measured at 3-ft intervals from the bottom of the aquifer to the water table in a network of continuously screened wells and are used to calculate the average groundwater density of the measurement interval. A smooth curve drawn through the points shows the variation of groundwater density with depth in the alluvial aquifer. The calculated densities closely agree with densities of groundwater samples taken from piezometers screened at various levels in the alluvial aquifer. The distributions of total dissolved solids or chloride concentrations can be inferred knowing the exact relationship between density and these parameters. (See also W88-09283) (Author's abstract)
W88-09294

APPLYING THREE DIMENSIONAL GROUND WATER MODELING TO MONITORING NETWORK DESIGN: A CASE HISTORY,
Camp, Dresser and McKee, Inc., Detroit, MI.
J. H. Schroeter, D. N. Day, P. Goudreault, and M. J. TenBroek.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 151-167. 7 fig.

Descriptors: *Model studies, *Hazardous materials, *Groundwater monitoring, *Network design, *Monitoring wells, *Chlorinated hydrocarbons, *Path of pollutants, Organic compounds, Minnesota, Geohydrology, Hydrology, Aquifers, Design criteria, Spatial distribution, Water pollution sources, Plumes, Trichloroethylene, Groundwater.

Groundwater modeling can serve as a valuable interpretive tool in the design of monitoring networks. This paper is a case history of such an application at New Brighton and Arden Hills, Minnesota where the local and regional groundwater systems are contaminated by volatile organic compounds (VOCs), primarily 1,1,2-trichloroethylene (TCE). Within an approximately 30 square mile area, a preliminary EPA study inventoried more than 400 potential sources that may have contributed to the observed groundwater contamination. The objectives of the Phase I remedial investigation included defining the horizontal and vertical extent of the contaminant plume and providing a preliminary identification of significant sources of contamination within the study area. (See also W88-09283) (Author's abstract)
W88-09295

UNDERGROUND STORAGE TANK MONITORING IN CALIFORNIA: AN EVALUATION OF RECENT LEGISLATION,
Kleinfelder (J.H.) and Associates, Walnut Creek, CA.
For primary bibliographic entry see Field 6E.
W88-09297

EXPECTING THE UNEXPECTED,
Oklahoma State Univ., Stillwater. Dept. of Geology.
W. A. Pettyjohn, D. J. Hagen, R. Ross, and A. W. Hounslow.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 196-215. 11 fig, 6 ref.

Descriptors: *Nitrates, *Sampling, *Variability, *Groundwater monitoring, *Soil contamination, *Water quality, *Monitoring wells, *Hydrology, *Geohydrology, Water pollution control, Vadose zone, Oklahoma, State jurisdiction, Soil water, Water chemistry, Spatial distribution, Aquifers, Groundwater.

A groundwater quality study in north-central Oklahoma (Stillwater) is described as an example of variable sampling results. The study collects data from 21 shallow wells that lie in an area of only about 7000 square feet. The wells tap an alluvium-weathered shale hydrologic unit that consists largely of silt and clay. The water level ranges between about 5.5 and 11.5 feet below land surface. Of the 21 wells, no two have ever had the same chemical quality and only rarely were the water levels the same during the nine months of monitoring. On a scale of months, there is little or no relation between water level and concentration in a single well. Nitrate concentrations can increase fourfold within two days following a rain and decrease to less than half the pre-rain concentration within another 48 hours. One normally would not expect such rapid changes in groundwater quality, particularly when the soil-moisture content is far below field capacity. Neither would one expect such a wide range in chemical constituents within only a few inches vertically and a few tens of feet laterally. The impact on groundwater monitoring is discussed. (See also W88-09283) (Author's abstract)
W88-09298

SUB-LINER GROUND WATER MONITORING AT A LARGE LINED LANDFILL,
Golder Associates, Mississauga (Ontario).
K. S. King, S. Feenstra, D. W. Reades, and A. Bacopoulos.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 247-259. 6 fig.

Descriptors: *Linings, *Landfills, *Groundwater monitoring, *Monitoring wells, *Waste disposal, *Groundwater pollution, Aquifers, Hydrology, Geohydrology, Sampling devices, Groundwater management, Performance evaluation, Water pollution sources, Ontario, Plumes, Groundwater.

The use of liners at landfill sites has posed a significant technical problem to the effective monitoring of groundwater beneath the landfill without decreasing the integrity of the liner. At the Keele Valley Landfill site, north of Toronto, Ontario, a former 245 acre sand and gravel pit is being lined with a 4 ft thick clay till liner. In addition to groundwater monitoring around the site, a liner performance monitoring program was initiated to ensure groundwater protection. As part of this program, sixty sub-liner water samplers were installed in the aquifer below the 66 acre Stage 1 area and covered by the liner. The samplers were grouped in six nests and spaced at 4 ft vertical intervals. Outlet tubing from the samplers runs horizontally beneath the liner along the floor of the pit and up the pit side slope to a monitoring building beside the pit at the margin of the landfill. The outlet tubing from the samplers does not pass through the liner. Groundwater samples have been collected since January 1984 from tubing up to 1400 ft in length over an elevation change of between 92 ft and 130 ft. Two types of commercially available samplers were used; a bladder type and a gas-drive type. Sampling results indicated the presence of a contaminant plume attributed to an unlined landfill directly upgradient of the presence site. The installation and operation of the sub-liner samplers at the Keele Valley site represents a significant and innovative technical achievement in groundwater monitoring. (See also W88-09283) (Author's abstract)
W88-09301

SCREEN LENGTH SELECTION FOR USE IN DETECTION MONITORING WELL NETWORKS,
Giddings (Todd) and Associates, Inc., State College, PA.
T. Giddings.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 316-319. 2 ref.

Descriptors: *Screens, *Groundwater monitoring, *Design criteria, *Plumes, *Monitoring wells, *Design standards, *Water pollution sources, *Network design, Economic aspects, Aquifers, Geohydrology, Path of pollutants, Costs, Groundwater.

Detection monitoring well networks are designed to give the earliest possible indication that a waste containment facility has failed to contain the waste. Long screen lengths in monitoring wells, because they are open to a wide vertical extent of the aquifer, provide the greatest sensitivity and the most comprehensive scope of monitoring. Long screen monitoring wells are also the most economical to construct, and also, in terms of the analytical costs, are the most economical to operate in a detection monitoring well network. To meet these design objectives, a monitoring well should be transparent and in complete hydraulic communication with the aquifer. Detection monitoring wells with long screen lengths come the closest to this ideal condition of being transparent within the aquifer flow system. Detection monitoring net-

works are not intended to define the rate of movement or exact flow path of the contaminant. The designer can utilize long screen lengths or long open bedrock bore lengths to achieve a construction of a monitoring well network that is sensitive in terms of providing the earliest detection, comprehensive in terms of monitoring all flow paths, and economical in terms of construction costs and analytical costs. (See also W88-09283) Alexander-PTT)
W88-09308

RATIONALE FOR SCREEN LENGTH SELECTION AND PLACEMENT,
Environmental Protection Agency, Denver, CO. Region VIII.
D. J. Shosky.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 320-327. 4 ref.

Descriptors: *Well screens, *Groundwater monitoring, *Monitoring wells, *Groundwater management, *Plumes, Design criteria, Design standards, Groundwater pollution, Geohydrology, Hydrology, Aquifers, Groundwater movement, Hydraulic conductivity.

Considerable controversy exists as to what is an adequate screen length for a groundwater monitoring well. An important aspect of any groundwater contamination study is obtaining representative samples from specific points within the groundwater flow system. The rationale involved in selecting and placement of monitoring well screen length is addressed and an argument is presented for short screen lengths. Many factors influence the length of well screen used in monitoring wells, including hydraulic conductivities of underlying geologic units, the rate and direction of groundwater flow, piezometric surface charges, and contaminant characteristics. Because all these factors vary in real monitoring situtations, short well screen lengths give a more precise picture. (See also W88-09283) (Alexander-PTT)
W88-09309

REVIEW OF MATERIALS USED IN MONITORING AND MONITORING WELL CONSTRUCTION,
Waste Management, Inc., Oak Brook, IL.
For primary bibliographic entry see Field 6E.
W88-09310

MONITORING AND RECOVERY OF FREE HYDROCARBONS,
Engineering Science, Cleveland, OH.
For primary bibliographic entry see Field 5G.
W88-09320

VADOSE ZONE MONITORING FOR HAZARDOUS WASTE SITES,
Kaman Tempo, Santa Barbara, CA.
L. G. Everett, L. G. Wilson, and E. W. Hoylman.
Noyes Data Corporation, Park Ridge, New Jersey. 1984. 251 p.

Descriptors: *Network design, *Groundwater pollution, *Water quality control, *Vadose water, *Monitoring, *Hazardous wastes, Groundwater quality, Disposal sites, Waste disposal, Landfills, Geohydrology.

A major concern at all hazardous waste disposal sites - abandoned, active, or planned - is potential pollution of the underlying groundwater system. Current federal regulations require both groundwater monitoring and vadose zone sampling at land treatment installations. This book is a compendium of monitoring techniques from which the user may select a method to develop a vadose zone monitoring program. More than 70 different sampling and nonsampling vadose zone monitoring techniques are described in terms of their advantages and disadvantages. Each of the methods is described according to physical, chemical, geologic, topographic, hydrologic, and climatic constraints. The monitoring techniques are categorized for premonitoring, active, and postclosure site assessments. Waste disposal methods are categorized for piles, landfills, impoundments, and land treatment. Conceptual vadose zone monitoring approaches are suggested for specific waste disposal method categories. (Lantz-PTT)
W88-09385

VARIABILITY OF THE PRECIPITATION PROCESS IN TIME AND SPACE,
Maryland Univ., College Park. Inst. for Physical Science and Technology.
H. E. Landsberg.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 3-9, 3 tab, 26 ref.

Descriptors: *Precipitation, *Spatial distribution, Time, Variability, Rain gages, Precipitation rate, Snow, Rain.

The spatial and temporal distribution of precipitation as well as its quantity is highly variable. The coefficient of variation is a function of total annual amount. The smaller the total precipitation, the greater the variability. Sampling procedures are very deficient. The small orifices of gages cause sizeable errors. Differences in amounts collected even by closely spaced gages can be very large, especially in summer. Time series of neighboring gages as little as 5 km apart may have correlations < 0.5. In rolling and mountainous terrain differences in single rain events can be tremendous. This will affect the dilution of aerosols that are washed out. Essential parameters are generally not measured. Principal among these are drop or flake diameters. These will affect both the dilution of the nuclei material and the efficiency of washout of aerosols. The number and nature of the cloud condensation nuclei are only observed in special projects. Drop sizes will change during single rain events, and the washout process will be strongly affected by the duration of precipitation events. Very few records exist of electrical charges on precipitation elements. These may have a fairly substantial influence on aerosol collection. All of these characteristics have an influence on precipitation chemistry. They will affect the choice of sampling equipment and the sampling frequency. Notable differences exist between liquid and frozen precipitation, and information must be available about various forms of precipitation for proper interpretation. The chemical nature of the condensation nuclei for cloud formation, ultimately ending up in liquid rain, is different from the freezing nuclei involved in solid precipitation. And in many instances rain may start out as snow, melting on its way down. In all instances, whatever chemical material is dissolved or suspended in precipitation is a mixture of both the nuclei necessary for condensation or sublimation and aerosol washed out below the cloud level, and gases incorporated into precipitation either in or below the cloud. The possibility of further chemical action among various components of advective and intercepted material makes it advisable to do any analysis as promptly as possible, preferably during the precipitation event. (See also W88-09387) (Author's abstract)
W88-09388

APPLICATIONS OF WITHIN-EVENT PRECIPITATION CHEMISTRY MEASUREMENTS,
Brookhaven National Lab., Upton, NY.
G. S. Raynor, and J. V. Hayes.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 50-60, 9 fig, 12 ref. DOE Contract No. DE-AC02-76CH00016 and EPA Contract No. EPA-DX-0533.

Descriptors: *Water analysis, *Precipitation, *Chemical analysis, *Sampling, Pollutant identification, Rain, Rainfall rate, Water pollution sources, Meteorology, Chemistry of precipitation.

Chemical measurements from hourly sequential precipitation samples and simultaneous meteorological measurements and observations were analyzed to discover relationships between chemical species, to infer atmospheric mechanisms, to relate precipitation chemistry to meteorological events and conditions, and identify probable pollutant source regions. Analytical methods that can be applied to short-period samples, but usually not to event, weekly, or monthly samples, are described and illustrated. Changes in concentrations of chemical species during precipitation events can be documented and used to infer atmospheric processes. These changes can be related also to meteorological conditions such as changes in rainfall rate and wind direction or to frontal passages. Source directions and probable source regions can be located by wind direction and trajectory analyses. Means of many samples taken under similar conditions can document relationships between meteorological conditions, concentrations in precipitation, and amounts of wet deposition. (See also W88-09387) (Author's abstract)
W88-09393

DATA COMPARABILITY: AN OBJECTIVE FOR PRECIPITATION CHEMISTRY MONITORING,
Southern Co. Services, Inc., Birmingham, AL.
J. J. Jansen.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 61-71, 1 fig, 7 ref.

Descriptors: *Water analysis, *Data interpretation, *Chemistry of precipitation, *Monitoring, *Acid rain, Comparison studies, Precipitation.

Data comparability is a stated or implied goal of a number of networks (for example, the Utility Acid Precipitation Study Program (UAPSP)). This concept is important if a research objective such as the national objective on precipitation chemistry monitoring is to be met using the combination of all the existing precipitation chemistry monitoring networks in North America. An analysis of the definition of data comparability shows that two steps are involved in establishing data comparability of two data sets: (1) to judge the adequacy of the data sets toward accomplishing the objective; and (2) to determine the uncertainty of each data set and that of the combined data set. Two methods are described to improve data comparability. The two methods can be represented by: (1) the responsibilities of the data gatherer; and (2) the responsibilities of the data analyst. In applying these methods toward meeting an example objective, it is shown that implementing and reporting quality control/quality assurance on the part of the data gatherers (that is, network operators) is the key stumbling block in the data analyst's attempts to determine the degree of data comparability. The UAPSP network is described, and the efforts to improve data comparability are discussed. The UAPSP has implemented both internal quality control and independent quality assurance to meet its responsibilities as a data gatherer. The UAPSP also sponsored a workshop in August 1982 to promote discussion of ways to improve data comparability among the networks in the future. (See also W88-09387) (Author's abstract)
W88-09394

SAMPLING, ANALYTICAL, AND QUALITY ASSURANCE PROTOCOLS FOR THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM,
Illinois State Water Survey Div., Champaign.
M. E. Peden.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 72-83, 9 fig, 2 tab, 5 ref.

Descriptors: *Monitoring, *Sampling, *Network design, *Acid rain, *Water sampling, *Water analysis, Precipitation, Rain, Regulations, Water quality control, Standards, Hydrogen ion concentration, Air pollution.

The Increasing concern regarding the quality of precipitation falling on the United States resulted in the formation of the National Atmospheric Deposition Program (NADP) in 1978. The first phase of the program, which was the development of a nationwide monitoring network, was organized in July 1978 by the North Central Region of the State Agricultural Experiment Stations. Currently, 90 sites across the country are participating in the collection of wet and dry deposition samples that are sent to a Central Analytical Laboratory (CAL) located at the Illinois State Water Survey. Site operators are required to determine pH and specific conductance before shipping samples to the CAL. Upon arrival, samples are analyzed for eleven parameters that include pH and specific conductance. To ensure reliable analytical results both at the field sites and at the CAL, a quality assurance program has evolved that includes intersite comparisons for pH and specific conductance, computer verification of all analytical results, plus the extensive use of 'blind' samples. Details of the internal controls used at the CAL are documented with supporting data from the first three years of network operations. (See also W88-09387) (Author's abstract)
W88-09395

UPDATING PROCESS IN PRECIPITATION QUALITY NETWORKS,
Atmospheric Environment Service, Downsview (Ontario).
M. E. Still.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 84-90, 2 fig, 1 tab, 2 ref.

Descriptors: *Network design, *Precipitation, *Data acquisition, *Acid rain, Monitoring, Chemical analysis, Data interpretation, Quality control.

With the increasing awareness of the effects on the environment of air pollution, the measurement of the various contributing processes has grown in importance. This paper looks at the monitoring of one of these processes, that of wet deposition caused by precipitation. In the design of a monitoring network measuring the quality of precipitation, there are five general factors to be considered for data quality: network objectives, network design, operations, chemical and data analyses, data products, and quality assurance. A continuous evaluation of all aspects of the network must be undertaken to ensure the quality of the data. The Canadian Network for Sampling Precipitation is used as an example. (See also W88-09387) (Author's abstract)
W88-09396

MANUAL OF GROUND-WATER QUALITY SAMPLING PROCEDURES,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 5A.
W88-09401

PRINCIPLES OF ENVIRONMENTAL SAMPLING.
Radian Corp., Austin, TX.
American Chemical Society. 1988. 458 p. Edited by Lawrence H. Keith.

Descriptors: *Water sampling, *Pollutant identification, *Sampling, *Water analysis, *Field tests, *Statistics, *Errors, *Monitoring, Quality control, Biota, Hazardous wastes, Industrial wastes, Sludges, Solid wastes, Preservation, Organic compounds, Inorganic compounds, Contamination, Groundwater, Surface water, Industrial wastewater, Wastewater analysis, Management planning.

The objective of environmental sampling is to take representative samples of a heterogeneous and changing locality in order to analyze for constituents that constitute a very tiny fraction of each sample (often at or below the parts per billion level). The matrix is often very complex, thereby facilitating analytical interferences such as masking and false positive tests. Other interferences can be introduced during transport and preservation of the sample. This book aims to ensure consideration of the many variables and special techniques that are needed to plan and execute reliable sampling activities. Chapters cover the following: overview of the sampling process; sampling for tests of hypotheses when data are correlated in space and time; nonparametric geostatistics for risk and additional sampling assessment; geostatistical approaches to design and sampling regimes; expert systems as aids in defining quality assurance and quality control sampling requirements; defining the accuracy, precision, and confidence limits of sample data; defining control sites and blank sample needs; assessing sampling and controlling sample contamination; storage and preservation of environmental samples; evaluating and presenting quality assurance sampling data; the impact of sampling variability on planning and confidence levels in water sampling; assessment of measurement uncertainty (heteroscedastic error components); modern sampling equipment; preservation techniques for organic and inorganic compounds in water samples; sampling groundwater monitoring wells; sampling surface and industrial waters; groundwater sampling; air quality sampling; sampling for organic compounds; quantifying dry deposition; quality control in stationary source sampling; sample variability in the biota; sample size in relation to quality assurance and quality control; composite sampling for environmental monitoring; preservation of biotic samples; sampling solids, sludges, and liquid wastes; and special considerations in sampling and analysis of hazardous and industrial wastes. (Cassar-PTT)
W88-09415

OVERVIEW OF THE SAMPLING PROCESS,
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
For primary bibliographic entry see Field 7B.
W88-09416

DEFINING CONTROL SITES AND BLANK SAMPLE NEEDS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
S. C. Black.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 109-117, 9 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Network design, *Experimental design, Blanks, Contamination, Sample preparation, Baseline studies, Statistical analysis, Calibration.

Controls and blanks are essential for experimental studies. A blank refers to an analytical procedure, whereas a control relates to a specific type of sample, that of the environment or of a population, against which the results of a procedure are judged. Types of blanks and their uses are as follows: (1) field blank--estimates incidental or accidental contamination of sample during collection; (2) transport blank--estimates sample contamination from the container and preservative used in transport and storage; (3) sample preparation blank--compensates for stirring, mixing, blending, or subsampling; (4) matrix blank--determines presence of analyte in matrix when the sample matrix is not distilled and deionized water; and (5) reagent blank--usually distilled and deionized water. Control samples are of two types: those used in quality control (laboratory control standard and matrix control) and those used to determine whether or not a factor of interest is present in a population under study but not in the control (local control site, area control site, national controls, and background sites). (See also W88-09415) (Cassar-PTT)
W88-09417

COMPOSITE SAMPLING FOR ENVIRONMENTAL MONITORING,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
F. C. Garner, M. A. Stapanian, and L. R. Williams.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 363-374, 1 tab, 17 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, *Biological samples, Composite sampling, Monitoring.

Guidance for selecting a plan to composite environmental or biological samples is provided in the form of models, equations, tables and criteria. Composite sampling procedures can increase sensitivity, reduce sampling variance, and dramatically reduce analytical costs, depending on the exact nature of the samples, the analytical method, and the objectives of the study. The process of taking random grab samples and individually analyzing each sample for elements, compounds, and organisms of concern is very common in environmental, biological, and other monitoring programs. However, the process of combining aliquots from separate samples and analyzing this pooled sample is sometimes beneficial. The researcher must consider detection limits, probability of analytic occurrence, criterion level, sample size, aliquot size, analyte stability, the number of samples, analysis cost, sampling cost, monetary resources, biological interactions, chemical interactions, and other factors in order to make a wise decision of whether to composite or not, and how many sample aliquots to composite. (See also W88-09415) (Author's abstract)
W88-09429

RELATIONS OF SAMPLING DESIGN TO ANALYTICAL PRECISION ESTIMATES,
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 5A.
W88-09432

DEVELOPING A STANDARDIZED SYSTEM FOR ENVIRONMENTAL ASSESSMENTS,
Shevenell Gallen and Associates, Inc., Portsmouth, NH.
J. B. Wathen, M. J. Gallen, and T. C. Shevenell.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Dublin, OH. 1987. p 545-558, 3 fig, 4 tab, 3 ref.

Descriptors: *Groundwater pollution, *Liability, *Public health, *Environmental impact statement, Evaluation, Environmental effects, Water pollution effects, Water law, Legal aspects, Correlation analysis.

Potential exposure to financial liability for the remediation of groundwater contamination has been of concern in recent years to financial institutions, property owners, and potential purchasers of real estate. This potential exposure has been addressed in many instances by the performance of environmental site assessments of properties, which have included groundwater sampling and analysis for the presence of contamination. The wide range of approaches to environmental assessments and the disparity of conclusions drawn by environmental professionals, suggest the need for a standardized system to rate the severity of detected groundwater contamination. Two hundred sixty sites in the northern New England area were examined. In instances where groundwater contamination was detected, the sites were ranked subjectively for severity. These rankings were then compared with the semi-quantitative ranking obtained from the application of a standardized system for evaluating waste-disposal sites proposed by Harry LeGrand and by two versions of the method used by the U.S. EPA to rate the impact of surface impoundments on groundwater quality. This comparison illustrates the benefits and limitations of such a standardized system, and provides a first step in the development of a ranking system that can be applied to properties where groundwater contamination has been identified. (See also W88-09477) (Author's abstract)

W88-09507

USE OF REMOTE SENSING, GEOPHYSICAL AND SOIL GAS TECHNIQUES TO LOCATE MONITORING WELLS AT HAZARDOUS WASTES SITES IN NEW HAMPSHIRE,
New Hampshire Dept. of Environmental Services, Concord.
J. M. Regan, M. S. Robinette, and T. R. Beaulieu.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 577-591, 9 fig.

Descriptors: *Groundwater pollution, *Remote sensing, *Groundwater movement, *Path of pollutants, Test wells, Geohydrology, Waste dumps, Geophysics, Mapping, Bedrock, Seismology, Water quality, New Hampshire, Landfills, Hazardous wastes.

Since 1983 the Hydrogeological Investigation Unit of the New Hampshire Water Supply and Pollution Control Division has been conducting hydrogeological investigations at selected hazardous waste sites in New Hampshire. During the course of these investigations, numerous groundwater monitoring wells have been installed. The budgetary constraints of each project have made it necessary to limit the number of groundwater monitoring wells at each site. This paper discusses several techniques which were used to provide a rationale in designing and locating each monitoring well in a cost-effective and technically justifiable manner. This paper outlines a systematic technical approach to locating monitoring wells which includes three distinct phases: (1) fracture trace analysis; (2) geophysical surveys; and (3) soil gas reconnaissance prior to final site selections. The fracture trace analysis includes: (1) photointerpretation and analysis of lineament trends; (2) field mapping of bedrock fractures and joints; and (3) evaluation of lineaments and fracture patterns with respect to the regional structural geology in order to evaluate potential pathways of groundwater movement in bedrock. The geophysical surveys include seismic refraction, electromagnetic methods, electrical resistivity, magnetometry and gravity to assess stratigraphic and water quality variations. Soil gas reconnaissance is a field technique which provides environmental chemistry information useful in locating the monitoring wells. The paper presents several examples where these techniques have been successfully used in a variety of hydrogeological settings. (See also W88-09477) (Author's abstract)
W88-09509

HIGH FREQUENCY PERCUSSION-DRIVEN MICRO-WELLS IMPROVE EFFICIENCY OF CONTAMINANT PLUME DEFINITION,
Pine and Swallow Associates, Acton, MA.
R. M. Cadwgan, and J. C. Swallow.
IN: Proceedings of the Fourth Annual Eastern Regional Ground Water Conference. Burlington, Vermont. July 14-16, 1987. National Water Well Association, Dublin, OH. 1987. p 749-757, 3 fig, 1 tab, 2 ref.

Descriptors: *Drilling, *Wells, *Groundwater pollution,*Pollutant identification, *Network design, *Monitoring, *Gas chromatography, Hydraulic machinery, Path of pollutants, Water pollution sources.

Portable equipment has been developed that drives slotted 0.62-inch (16 mm) internal diameter steel pipe (micro-wells) at penetration rates averaging 4 ft/min to depths exceeding 100 ft in unconsolidated deposits. Numerous field applications demonstrate that vibratory drilling is faster than augering techniques. Together with ultra-sensitive gas chromatographs that yield reliable, on-site VOC analyses rapidly, definition of contaminant source areas, stratified plume characteristics and plume boundaries have been accomplished at costs 18 to 43% below those of conventional drilling methods. Lower unit costs of micro-wells with on-site gas chromatographic analysis can translate into better subsurface coverage, more aquifer measurements per dollar and stronger hydrogeologic conclusions. (See also) W88-09477) (Author's abstract)

W88-09518

WATER RESOURCES ASSESSMENT: A SPATIAL EQUILIBRIUM APPROACH,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
C. M. Marin, and M. G. Smith.
Water Resources Research WRERAO, Vol. 24, No. 6, p 793-801, June 1988. 7 fig, 3 tab, 15 ref.

Descriptors: *Data collections, *Data acquisitions, *Network design, *Water resources development, *Model studies, Water policy, Operations research, Cyprus, Water demand, Economic efficiency, Costs, Regional planning, Planning.

A spatial equilibrium approach was used for screening level water resources assessment. The approach complements traditional hydrologically based water resources assessment methods by providing a model capable of evaluating national-regional strategies with respect to four principal objectives of water resources policy: supply-demand balance, economic efficiency, cost recovery, and equity. The proposed approach has a number of advantages. First, it provides a simple yet generalizable representation of the spatial environment at a number of scales. Second, the assessment is freed from the constraint of requiring a highly detailed hydrologic description. Third, an objective-constraint structure provides the basis for defining, organizing, and collecting the data necessary for the assessment. Finally, simulation is used in conjunction with optimization to evaluate alternative allocation scenarios. A case study in Cyprus demonstrates use of the model for policy analysis. (Author's abstract)
W88-09538

VICTORIA PROVINCE DROUGHT RELIEF PROJECT: I. GEOPHYSICAL SITING OF BOREHOLES,
Hydrotechnica, Shrewsbury (England).
For primary bibliographic entry see Field 2F.
W88-09784

COMPARATIVE STUDY OF AREAL RAINFALL ESTIMATION METHODS USING RAIN GAGE AND RADAR DATA - APPLICATION TO DAILY RAINFALL EVENTS OBSERVED IN THE MONTREAL REGION (ESTIMATION DE LAMES D'EAU SPATIALES A L'AIDE DE DONNES DE PLUVIOMETRES ET DE RADAR METEOROLOGIQUE - APPLICATION AU PAS DE TEMPS JOURNALIER DANS LE REGION DE MONTREAL),
Institut de Mecanique de Grenoble, Saint-Martin d'Heres (France).
For primary bibliographic entry see Field 2B.
W88-09979

NONPOINT SOURCE POLLUTION MONITORING PROGRAM DESIGN,
Washington Univ., Seattle. Dept. of Civil Engineering.
L. E. Reinelt, R. R. Horner, and B. W. Mar.
Journal of Water Resources Planning and Management JWPED5, Vol. 114, No. 3, p 335-352, May 1988. 4 fig, 5 tab, 28 ref, 1 append.

Descriptors: *Water pollution sources, *Water pollution, *Rivers, *Network design, *Nonpoint pollution sources, *Water quality, *Stillaquamish River Basin, *Pollution load, *Computer programs, Monitoring, Fortran, Watershed analysis, Management planning, Data collection.

This paper describes a computer-aided methodology designed to aid in the determination of water quality and ecological change resulting from nonpoint sources of water pollution. The nonpoint monitoring program design conceptual model developed by the writers involves the following steps: (1) The definition of monitoring program objectives to guide data-collection efforts; (2) a choice of levels of detail to apply in carrying out the various steps of the procedure; (3) a watershed analysis to identify locations of the potentially most critical pollutant loadings; (4) the development of a monitoring program to detect and verify statistically the source or sources of a nonpoint pollution problem; and (5) prioritization of monitoring tasks with reference to the program objectives. Spreadsheet software with graphics is used to simplify the watershed analysis. FORTRAN programs are applied to facilitate the design of alternative sampling programs and to prioritize the tasks. A case study example on the Stillaquamish River Basin in Washington State is presented to demonstrate an application of the model. (Author's abstract)
W88-09985

REGIONALIZED VARIABLE THEORY AND THE ASSESSMENT OF THE CONSEQUENCES OF UNCERTAINTY IN THE OPTIMAL DESIGN OF WATER QUALITY SAMPLING NETWORKS,
Wisconsin Univ., Milwaukee. Dept. of Civil Engineering.
R. D. Morris.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8708853. Ph.D Dissertation, 1986. 141 p, 34 fig, 1 tab, 41 ref, 2 append.

Descriptors: *Optimization, *Water sampling, *Monitoring, *Water quality, *Network design, *Variability, Estimating, Algorithms, Sampling, Quantitative analysis, Computer programs, Markov process.

Methodology for the optimal design of water quality sampling networks uses a function describing the consequences of uncertainty as a measure for the comparison of sampling network configurations. The function combines a measure of uncertainty for areas of the sampling region with expected values throughout the region. Universal kriging provides a measure of degree of uncertainty for the parameter of interest in the form of an estimation variance. Defining a grid of potential sample locations along with a proposed sampling network allows for calculation of this estimation variance at unsampled locations. Since the consequences of uncertainty for these points varies in accordance with the level of water quality at the points, the second element of the design objective function depends upon a curve reflecting the expectations for the water quality parameter over the grid. A function of this expectation provides a weight for use in conjunction with the kriging estimation variance. This procedure yields the consequence function. The minimization of the maximum and average values of this function depends on an optimization algorithm to move sampling points around the grid of potential locations until such a minimum is obtained. (Cremmins-AEPCO)
W88-10080

7B. Data Acquisition

LINKING AUTOMATED BIOMONITORING TO REMOTE COMPUTER PLATFORMS WITH SATELLITE DATA RETRIEVAL IN ACIDIFIED STREAMS,
Tennessee Technological Univ., Cookeville. Center for the Management, Utilization and Protection of Water Resources.
For primary bibliographic entry see Field 5C.
W88-08967

MANUAL OF GROUND-WATER QUALITY SAMPLING PROCEDURES,
Robert S. Kerr Environmental Research Lab., Ada, OK.
M. R. Scalf, J. F. McNabb, W. J. Dunlap, R. L. Cosby, and J. S. Fryberger.
National Water Well Association, Worthington, Ohio. 1981. 93 p, 32 fig, 2 tab, 48 ref, 2 append.

Descriptors: *Sampling, *Groundwater quality, *Manuals, *Water sampling, Sample preparation, Geohydrology, Wells, Construction, Monitoring, Groundwater pollution.

Recent environmental legislation has recognized the importance of groundwater quality protection

and the stresses that man's activities, especially waste disposal, place on this vital national resource. To provide a realistic assessment of current and potential pollution problems and a rational basis for groundwater quality protection, it is necessary to collect representative samples from this remote and relatively inaccessible environment. This report presents some procedures currently utilized to sample groundwater and subsurface earth materials for microbial and inorganic and organic chemical parameters. In selecting a sampling procedure, a number of considerations are described based on the objectives of the sampling program, characteristics of pollutants, nature of pollution source and geohydrology of the area. Various techniques for constructing sampling wells and for withdrawing samples are described with advantages and disadvantages of each method listed. For situations where samples of subsurface earth materials are required to adequately assess groundwater quality threats, procedures are described for collecting, handling, and processing core samples. Finally, sample preservation, sample records, and chain of custody procedures are discussed. (Author's abstract)
W88-08970

GROUND-WATER TRACERS,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W88-08971

GUIDE TO THE SELECTION OF MATERIALS FOR MONITORING WELL CONSTRUCTION AND GROUND-WATER SAMPLING,
Robert S. Kerr Environmental Research Lab., Ada, OK.
M. J. Barcelona, J. P. Gibb, and R. A. Miller.
Illinois State Water Survey, Champaign, Illinois. SWS Contract Report 327, August 1983. 78 p, 5 fig, 18 tab, 160 ref. EPA Contract CR-809966-01.

Descriptors: *Observation wells, *Water sampling, *Wells, *Construction standards, *Materials, Groundwater quality, Waste disposal, Disposal sites, Monitoring, Sampling.

The presence of many trace substances in groundwater, even at very low concentrations, may create short-term or long-term health hazards. The inclusion of approximately 113 organic chemicals on the EPA priority pollutant list indicates the significance accorded these chemicals by U.S. health officials. Regulatory agencies are charged with regulating the disposal of waste to insure that the environment is not adversely affected. To accomplish this task, these agencies must set design and operational standards based on available technology to minimize potential pollution. Disposal facilities then must comply with these standards and monitor the effects of their operation on the surrounding environment. The use of wells or piezometers for collecting water samples and water level data has been and probably will continue to be the method for monitoring the effects of waste disposal facilities on groundwater. The objectives of this document/project are: (1) To assess the state of knowledge of the potential effects of well construction and pump and sampling materials on the integrity of groundwater samples, and (2) To develop a guide that will facilitate the selection of pumps and devices used to collect water samples, and materials used in the construction of monitoring wells. To achieve these objectives, the project was divided into two phases. Phase One entailed a thorough investigation and assessment of the existing literature. Phase Two involved laboratory and field studies to identify and assess efficient sampling techniques and materials for groundwater monitoring near waste disposal sites. This manual represents the culmination of the work in Phase One of the project. (Lantz-PTT)
W88-08972

PRACTICAL GUIDE FOR GROUND-WATER SAMPLING,
Robert S. Kerr Environmental Research Lab., Ada, OK.
M. J. Barcelona, J. P. Gibb, J. A. Helfrich, and E. E. Garske.
Illinois State Water Survey, Champaign, Illinois. SWS Contract Report 374, November 1985. 94 p, 24 fig, 16 tab, 86 ref. EPA Contract No. CR-809966-01.

Descriptors: *Sampling, *Water sampling, *Groundwater monitoring, *Groundwater quality, *Monitoring, Standards, Geohydrology, Wells, Water analysis.

Groundwater monitoring is a complex undertaking. Cost-effective monitoring relies on careful planning and critical reading of the scientific literature. Routine monitoring efforts may be sustained for decades. Therefore, as the data base for a specific situation is developed, it is unreasonable to follow preliminary guidelines offered for generalized monitoring activities. The practical elements of a viable long-term groundwater monitoring effort include: (1) Evaluation of hydrogeologic setting and program information needs; (2) Proper well placement and construction; (3) Evaluation of well-performance and purging strategies; (4) Execution of effective sampling protocols which include the appropriate selection of sampling mechanisms and materials, as well as sample collection and handling procedures. Actual sampling and analytical performance (accuracy, precision, detection and quantitation limits) which ensures the collection of water originating from the formation of interest should be established in every monitoring effort, regardless of the specific information needs of individual programs. This can best be assured by the implementation of quality assurance and quality control measures which are checked and documented carefully. The current state of understanding of effective monitoring procedures requires that common sense also play a large part in planning groundwater sampling efforts. (Lantz-PTT)
W88-08974

RCRA GROUND WATER MONITORING TECHNICAL ENFORCEMENT GUIDANCE DOCUMENT (TEGD).
For primary bibliographic entry see Field 4B.
W88-08976

SOIL GAS SENSING FOR DETECTION AND MAPPING OF VOLATILE ORGANICS,
Nevada Univ., Las Vegas. Environmental Research Center.
For primary bibliographic entry see Field 5A.
W88-08978

METHODS FOR DETERMINING THE LOCATION OF ABANDONED WELLS,
National Water Well Association, Worthington, OH.
L. Aller.
National Water Well Association, Worthington, OH. EPA Report No. EPA-600/2-83-123, January 1984. 130 p, 41 fig, 3 tab, 80 ref, 2 append. EPA Contract CR-809353.

Descriptors: *Groundwater, *Wells, *Abandoned wells, *Data acquisition, *Geophysics, Resistivity, Conductivity, Radar, Remote sensing, Aerial photography, Magnetic studies, Infrared imagery, Oil wells, Boreholes.

A search for abandoned wells may have three different objectives: (1) to provide an overview of the presence or absence of abandoned wells within an area, (2) to determine the status of a particular well and establish the potential impact of that well, and (3) to actually field locate the abandoned well. The scope of a search may encompass all or any combination of these objectives before the search is completed. To date, few methods have been successfully used to search for abandoned wells. This document contains a discussion of the application of methods which historically have been used to locate abandoned wells including record searching, talking with residents, using visual and logical clues to look for the well, walking over the area with a metal detector or magnetometer and excavation. Additionally, this document addresses technologies which may not have been specifically developed for locating abandoned wells, but which may have future application. These technologies include geophysical methods such as electrical resistivity, electromagnetic conductivity and ground penetrating radar, remote sensing techniques such as black and white aerial photographs, color photographs, color infrared imagery and thermal imagery, and indirect methods such as water-level measurements or actual injection. Although this document has been specifically designed to outline methods for the location of abandoned oil and gas wells, the techniques described herein may also be applicable to locating abandoned water wells, mineral exploration boreholes, engineering borings and similar subsurface excavations. (Lantz-PTT)
W88-08982

1987 ANNUAL BOOK OF ASTM STANDARDS.
American Society for Testing and Materials, Philadelphia, PA.
Volume 11.04: Pesticides; Resource Recovery; Hazardous Substances and Oil Spill Response; Waste Disposal; Biological Effects. American Society for Testing Materials, Philadelphia, PA. 1987. 1104 p.

Descriptors: *Water pollution, *Water analysis, *Standard methods, *Fate of pollutants, *Waste disposal, *Pesticides, *Environmental effects, *Wastewater treatment, Resource recovery, Hazardous wastes, Oil pollution, Cleanup operations, Biological studies.

The standard methods for water and pollutant analysis, pesticide evaluation, and response to pollution in this volume are under the jurisdiction of the following ASTM Committees: D-34 on Waste Disposal, D-34 on Pesticides, E-38 on Resource Recovery, E-47 on Biological Effects and Environmental Fate, and F-20 on Hazardous Substances and Oil Spill Response. Standards in this book are arranged in alphanumeric sequence and provide test methods, practice for, guides for, or proposed guides for: (1) waste disposal; (2) pesticides; (3) resource recovery; (4) biological effects and environmental fate of pollutants; and (5) hazardous substances and oil responses. (See W88-08987 thru W88-08988) (Lantz-PTT)
W88-08986

1987 ANNUAL BOOK OF ASTM STANDARDS.
American Society for Testing and Materials, Philadelphia, PA.
For primary bibliographic entry see Field 5A.
W88-08987

1987 ANNUAL BOOK OF ASTM STANDARDS.
American Society for Testing and Materials, Philadelphia, PA.
Volume 11.01: Water (I). American Society for Testing Materials, Philadelphia, PA. 1987. 815 p.

Descriptors: *Standard methods, *Chemical analysis, *Physical properties, Inorganic compounds, Standards, Conductivity, Corrosivity, Hydrogen ion concentration, Turbidity, Hardness, Chemical properties, Acidity, Alkalinity, Odor, Water sampling, Flow measurements, Specific gravity.

The methods in this volume are under the jurisdiction of ASTM Committee D-19 on Water. This committee is concerned with the study of water, the promotion of such knowledge, and the standardization of terminology and methods for: (1) sampling and analysis of water, water-borne materials and wastes, water-formed deposits; (2) the determination of the structure, function, and condition of communities of indigenous and other aquatic organisms; (3) surface water hydraulics and hydrologic measurements; (4) the determination of the performance of materials used to modify water characteristics; and (5) the determination of the corrosivity or deposit-forming properties of water. Standards in this volume cover the following categories: (1) Definitions, Specifications, Reagents, and Reporting Results; (2) Sampling and Flow Measurement of Water and Steam; (3) General Properties of Water (such as acidity or alkalinity, conductivity, corrosivity, hardness, odor, pH, specific gravity, and turbidity); and (4) Inorganic Con-

stituents. (See also W88-08986 thru W88-08987) (Lantz-PTT)
W88-08988

DECONTAMINATION OF RUBBER HOSE AND 'TEFLON' TUBING FOR GROUND WATER SAMPLING,
California Regional Water Quality Control Board, Sacramento. Central Valley Region.
For primary bibliographic entry see Field 5A.
W88-09000

RESOLUTION PROBLEMS WITH OBTAINING ACCURATE GROUND WATER ELEVATION MEASUREMENTS IN A HYDROGEOLOGIC SITE INVESTIGATION,
EMCON Associates, San Jose, CA.
D. F. Atwood, and B. Lamb.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 185-192. 2 fig, 1 tab.

Descriptors: *Errors, *Water level, *Groundwater level, *Measuring instruments, *Analytical methods, *Monitoring wells, Groundwater management, Aquifers, Hydrology, Groundwater, Water level fluctuations.

An on-going 2-year study of water level accuracy shows that the resolution of groundwater elevation depends on (1) water level measurement errors that if recognized can be remediated and (2) water level errors that may be quantified but not eliminated. The first type of accuracy problems includes measurement mistakes by operators, equipment inaccuracies, deviation of the well from vertical, and surveying precision. Many of these errors can be avoided by using care and consistency while determining the groundwater elevations. The second type of water level resolution problem, which cannot be eliminated, is the accuracy limits of the measurement equipment and temporally-dependent natural water level fluctuations. Equipment used to determine well deviation and measure well head elevations has limits of accuracy that are cumulative when comparing water levels between wells. A comparison of manual measurements obtained using an electric sounding device with those taken by a downhole transducer show an overall accuracy of + or - 0.10 foot, which is due to several factors, including sounder sensitivity and operator error. Natural water level fluctuations can provide the greatest potential for discrepancy in comparing water level elevations. Continuous water level data taken over a 2-month period at a waste disposal facility show water level fluctuations up to 0.8 foot. Awareness of potential sources for error will help increase the precision of groundwater level measurement, but cannot eliminate all inaccuracies. (See also W88-08991) (Author's abstract)
W88-09001

VALUE OF ON-SITE MEASUREMENTS IN MAXIMIZING GROUND WATER SAMPLING RELIABILITY,
Hydrolab Corp., Austin, TX.
S. Garner.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 193-213. 2 fig, 48 ref.

Descriptors: *Sampling, *Contamination, *Sensors, *Precision, *Water quality, *Groundwater monitoring, *Monitoring wells, Field tests, Aquifers, Temperature, Measuring instruments, Hydrogen ion concentration, Groundwater management, Groundwater, Conductivity, Dissolved oxygen, Sampling devices, Oxidation-reduction potential.

The primary groundwater quality parameters temperature, pH, Eh, electrical conductivity, and dissolved oxygen must be measured at the wellhead to avoid errors caused by contamination such as aeration. Monitoring of these values during the purging of a well can also verify aquifer-representativeness of a sample, detect abnormalities within an aquifer, be correlated with laboratory measurements to detect sample deterioration or procedural errors, and prompt further monitoring actions. Electronic sensors are available for accurate field measurement of the primary parameters, but a rudimentary knowledge of the principles of operation for these devices in necessary to maximize their reliability. Calibration of the instrumentation should involve standards whose values approximate the parameter values and temperatures likely to be encountered in the field. For best results, measurements should be made continuously in an in-line flow cell that is sealed from the atmosphere. Flow can be provided by a bladder pump dedicated to a single well. Samples for laboratory analysis should be collected when the value of the primary parameters does not vary more than ten percent per casing volume pumped. (See also W88-08991) (Author's abstract)
W88-09002

FALSE WHAT: FALSE POSITIVE RATES IN GROUNDWATER MONITORING,
L. W. Heath.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 217-235. 9 tab, 3 ref, append.

Descriptors: *Resources Conservation and Recovery Act, T-tests, *False positives, *Data interpretation, *Groundwater monitoring, *Monitoring wells, *Statistical methods, *Water quality, Analytical methods, Groundwater management, Measuring instruments, Sampling devices, Mathematical studies, Aquifers, Groundwater, Seasonal variation.

The U.S. Environmental Protection Agency (EPA) published the Resource Conservation and Recovery Act (RCRA) Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD) in September 1986. The TEGD presents an alternative method, referred to as the Averaged Replicate (AR) t-test, for statistically analyzing groundwater monitoring data for RCRA interim status facilities. Enforcement officials, state and federal attorneys, permit writers, etc. are intended to use the guidance document to assist, rather than regulate, the evaluation of groundwater monitoring systems. However, it is prudent that owners/operators of interim status facilities, their consultants, and their attorneys fully understand the statistical procedures. The background (up-gradient) data base of indicator parameters represents the groundwater chemical characteristics to which subsequent analytical results are statistically compared. The AR t-test eliminates the false positive testing frequently required when using the Cochran's Approximation to Behrens-Fisher (CABF) t-test. The AR t-test is advantageous to owners/operators of interim status facilities because the application of the test to monitoring data reduces false positives; yet, maintains compliance with the statistical analysis requirements of 40 CFR, part 265, Subpart F. The false positive rate may also be further reduced by applying corrections for seasonal variations in the data. (See also W88-08991) (Author's abstract)
W88-09003

USE OF GROUND WATER TRACER DURING WELL INSTALLATION,
Woodward-Clyde Consultants, Chicago, IL.
D. Meiri, M. Ghiasi, N. Ramanujam, and M. Tyson.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 285-297. 9 fig, 9 ref.

Descriptors: *Tracers, *Water supply development, *Contamination, *Quality control, *Monitoring wells, *Design standards, *Groundwater monitoring, Aquifers, Design criteria, Analytical methods, Organic compounds, Groundwater, Sodium bromide, Water quality.

A tracer technique was used to evaluate potential for formation water contamination during well installation at a Superfund hazardous waste site in Ohio. Three wells, a shallow well penetrating the upper till aquifer, an intermediate well penetrating the weathered shale aquifer, and a deep well penetrating the bedrock shale were installed. The deep and intermediate wells were constructed with double casing so that the outer casing would isolate the till zone from the shale. The shallow well was constructed with single casing. A tracer of sodium bromide was introduced into the drilling fluid during the construction of the deep and intermediate wells. The tracer concentration was recorded during well development. At the beginning of the intermediate well development, the tracer concentration the formation water was about 16 times greater than the background bromide concentration. This indicated that drilling fluid had mixed with the formation water. Approximately 54 well casing volumes of water were removed from the intermediate well to reduce the tracer concentration to near background level. On the other hand, after removing slightly more than one well casing volume from the deep well, the tracer concentration in the formation water remained near background level. The use of a tracer proved to be an efficient and inexpensive way to verify the potential for monitoring well contamination during well construction using drilling fluids. The tracer showed the importance of well development and gave an indication of the volumes to be removed to restore the natural water quality conditions. (See also W88-08991) (Author's abstract)
W88-09007

MONITOR WELLS FOR DEPTH-DISCRETE SAMPLING: A COST-EFFECTIVE ALTERNATIVE DESIGN,
Geoscience Consultants Ltd., Albuquerque, NM.
For primary bibliographic entry see Field 7A.
W88-09008

INSTALLATION OF A SEDIMENT-FREE MONITORING WELL IN FINE-GRAINED SEDIMENT,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
M. N. Gallagher.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 311-323. 4 fig, 4 tab, 7 ref.

Descriptors: *Sampling, *Filters, *Well installation, *Contamination, *Monitoring wells, *Groundwater monitoring, Sediments, Groundwater management, Design criteria, Design standards, Aquifers, Sampling devices, Hydraulic conductivity, Permeability coefficient, Groundwater, Rock properties, Monitoring.

The installation of a monitoring well and collection of a representative sediment-free groundwater sample from a fine grained formation is at best difficult. The results of this study indicate that a granular filter cannot be designed for formations containing greater than 50 percent fines. Consequently, sediment-free monitoring wells cannot be installed in formations containing greater than 50 percent fines unless non-standard well installation/sampling methods are used. Each of the non-standard methods discussed have limitations which must be evaluated with respect to the goals of the investigation. Additional research is required to document the applicability of these and other potential methods. In formations with greater than 50 percent fines a monitoring well can be designed and, if properly installed and developed produce a sediment free sample. In practice, developing a monitoring well to a sediment free condition may preclude using it for hydraulic conductivity testing. (See also W88-08991) (Author's abstract)
W88-09009

GUIDE TO THE SELECTION OF CEMENT, BENTONITE AND OTHER ADDITIVES FOR USE IN MONITOR WELL CONSTRUCTION,
California Regional Water Quality Control Board, Sacramento. Central Valley Region.

C. Williams, and L. G. Evans.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 325-343. 9 tab, 22 ref.

Descriptors: *Sealants, *Construction materials, *Cement, *Bentonite, *Grouting, *Monitoring wells, *Design criteria, Groundwater management, Design standards, Water quality, Groundwater, Monitoring, Annular seals, Quality control.

When cement is chosen to create an annular seal, the slurry can be designed to meet the physical and chemical conditions encountered by a monitor well. There are different cements and additives, including bentonite, which, if properly selected, mixed and placed will yield effective annular seals. Literature has been compiled to promote a technically sound approach for slurry design. Cement is a complex material. It has several classes each of which have different physical properties. Cementing additives can be grouped into the following categories: extenders, accelerators, retarders, weighting agents, fluid loss control additives, lost circulation control additives and dispersants. There are also special cement systems that may have their application in monitor well construction. Regardless of the materials selected to create an annular seal, the quality and quantity of mix waters are a crucial component and should be controlled. If there is a technically sound choice of annular seal materials and if documentable quality control measures are implemented throughout the blending, mixing and placement processes, then repercussions on water quality should not occur. With quality control in place, the selection of cement and additives can produce effective annular seals for monitor wells. (See also W88-08991) (Author's abstract)
W88-09010

CEMENT BENTONITE GROUT AND ITS EFFECT ON WATER QUALITY SAMPLES: A FIELD TEST OF VOLCLAY GROUT,
R. V. Colangelo, and G. R. Lytwynyshyn.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 345-359. 5 fig, 1 tab, 8 ref.

Descriptors: *Construction materials, *Cement, *Bentonite, *Grouting, *Volclay grout, *Sealants, *Monitoring wells, *Groundwater monitoring, Hydrogen concentration, Groundwater management, Analytical methods, Sampling devices, Aquifers, Water quality, Performance evaluation, Comparison studies, Physical properties, Groundwater, Field tests.

Drilling methods, well materials, and installation procedures may alter the quality of groundwater samples. Recent data indicate that annular space materials, specifically cement-bentonite grout, can also affect the quality of water samples, especially the pH. Data collected from a recent field study indicate that representative water samples can be obtained from monitoring wells when well construction materials and installation methods are adjusted. Representative pH values have been obtained from water samples by substituting American Colloid Volclay grout for cement-bentonite grout to fill the annular space of monitoring wells, and/or by increasing the length of the filter pack, increasing the length of the bentonite seals and extending the hydration time of the seals. However, Volclay grout cannot be used under all field conditions including: artesian pressure, saline groundwater environments or where alcohols or ketones are present, and where structural support is needed. Where Volclay grout has been used it appears to work well. Additional information is needed to identity the properties of Volclay grout in unsaturated zones and determine its trace element composition. (See also W88-08991) (Author's abstract)
W88-09011

USING THE DRILL THROUGH CASING HAMMER METHOD FOR MONITORING WELL CONSTRUCTION AND WATER QUALITY CHARACTERIZATION IN A METAL CONTAMINATED GRAVEL, COBBLE AND BOULDER AQUIFER,
Montana Univ., Missoula. Dept. of Geology.
W. W. Woessner.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 373-397. 16 fig, 1 tab, 5 ref.

Descriptors: *Construction methods, *Drilling, *Boulders, *Monitoring wells, *Groundwater monitoring, *Water quality, Groundwater pollution, Heavy metals, Aquifers, Water pollution sources, Water chemistry, Statistical methods, Groundwater, Montana, Arsenic, Iron, Manganese, Zinc, Chloride, Sulfate, Calcium, Manganese, Magnesium, Bicarbonates, Sodium, Potassium, Dissolved solids, Hydrogen ion concentration.

Arsenic concentrations ranging from 0.14 to 0.54 mg/L were discovered in four wells serving the residents of Milltown, Montana. The wells penetrated an unconfined alluvial aquifer up to 150 ft thick which overlies Precambrian bedrock. In 1983, the EPA initiated a program designed to last six months which would document the source or sources of As and other metals and locate a site for a replacement water supply. The coarse unconsolidated sediments, occurrence of boulders, anticipated large hydraulic conductivities, undesirability of using drilling fluids other than air or water, a desire to complete over 2,000 ft of drilling in as short a time as possible and the need to install PVC casing resulted in the use of forward air rotary equipment combined with a drill through casing hammer. At 13 sites, eight or six inch diameter steel casing was drilled and driven to the desired depth and either a single four or two inch diameter PVC monitoring well or a bundle of two two inch diameter wells were constructed as steel casing was jacked back to the surface. The bottom 10 feet of hole contained five feet of screen which was gravel packed, and the hole sealed with bentonite above the gravel pack. Water samples collected during drilling were analyzed for As, Fe, Mn, Zn, Cl, SO4, HCO3, Na, K, Ca, K, total dissolved solids and pH. Comparison of chemistry data collected during drilling with those from monitoring wells completed at similar depths showed data did not fit a Y=X relationship where Y = the value of the parameter in well samples an X = the value of the parameter observed during drilling. The distribution of data for each constituent fell on both sides of the zero difference line. Moderately strong linear correlation coefficients were found for HCO3, Mn, Mg and Ca. Linear correlation coefficients for other constituents were weak. (See also W88-08991) (Author's abstract)
W88-09013

IN-SITU HYDRAULIC CONDUCTIVITY MEASUREMENTS OF SLOWLY PERMEABLE MATERIALS USING A MODIFIED GUELPH PERMEAMETER AND THEGUELPH INFILTRAMETER,
Guelph Univ. (Ontario). Dept. of Land Resource Science.
For primary bibliographic entry see Field 7A.
W88-09018

APPLICATION OF GRAVITY AND SEISMIC METHODS IN HYDROGEOLOGICAL MAPPING AT A LANDFILL SITE IN ONTARIO,
Ontario Ministry of the Environment, Toronto.
For primary bibliographic entry see Field 7A.
W88-09019

APPLICATION OF SEISMIC REFRACTION AND TERRAIN CONDUCTIVITY METHODS AT A GROUND WATER POLLUTION SITE IN NORTH-CENTRAL NEW JERSEY,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 7A.
W88-09020

OFF-END SURFACE SEISMIC REFLECTION SOUNDING WITH VERTICAL SEISMIC PROFILING IN GLACIAL TERRAIN,
Minnesota Dept. of Natural Resources, St. Paul. Div. of Waters.
For primary bibliographic entry see Field 7A.
W88-09021

USE OF GROUND-PENETRATING RADAR FOR DETERMINING DEPTH TO THE WATER TABLE ON CAPE COD, MASSACHUSETTS,
Geological Survey, Boston, MA. Water Resources Div.
D. G. Johnson.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 541-554. 7 fig, 1 tab, 7 ref.

Descriptors: *Mapping, *Aquifer characteristics, *Radar, *Measuring instruments, *Remote sensing, *Groundwater monitoring, *Geophysics, *Geohydrology, Aquifers, Data interpretation, Groundwater, Cap Cod, Analytical methods, Glacial aquifers, Aeration zone, Groundwater management, Massachusetts, Land fills, Performance evaluation.

Ground-penetrating radar is being used to map the water table in an area of glacial outwash in the towns of Brewster and Harwich on Cape Cod, Massachusetts. To date, 60 lines, ranging from 2,000 to 20,000 feet in length, have been completed, and a water-table map has been produced for an area of approximately 1-square-mile about a landfill. Preliminary results show that, in areas of sand and gravel, radar data can be collected at a rate of 2 to 5 miles per hour and are accurate to within + or - 2 feet to depths of 75 feet below land surface. However, in areas of fine-grained material, the radar signal is attenuated and depth of signal penetration is less than 3 feet. In addition, the definition of the water table generally is better in coarse material than in fine material because capillarity in coarse material is less and, therefore, is easier to locate on the graphic record. Average velocity of signal propagation in the unsaturated zone at 60 sites where the depth to water was known was 0.43 foot per nanosecond. The velocity of signal propagation in the unsaturated zone is not affected by the composition of the road material over which the radar traverse is made. However, radar signal attenuation is increased, but the increase can be compensated for by adjusting signal gains and computer processing. (See also W88-08991) (Author's abstract)
W88-09022

SHALLOW STRATIGRAPHIC REFLECTIONS FROM GROUND PENETRATING RADAR,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
T. M.. Cosgrave, J. P. Greenhouse, and J. F. Barker.
IN: Proceedings of the First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods. National Water Well Association, Dublin, OH. 1987. p 555-569. 5 fig, 9 ref.

Descriptors: *Radar, *Glacial aquifers, *Aquifer characteristics, *Stratigraphy, *Measuring instruments, *Remote sensing, *Geophysics, *Geohydrology, Groundwater monitoring, Groundwater management, Groundwater pollution, Groundwater movement, Physical properties, Soil properties, Hydraulic conductivity, Permeability coefficient, Data interpretation, Groundwater, North Bay, Analytical methods, Ontario, Reflectometry.

A number of ground penetrating radar profiles have been run along a transect that intersects a major groundwater contamination plume near North Bay, Ontario. The geological setting is predominantly glaciolacustrine. Groundwater flow velocities are as much as 300 meters per year and natural groundwater conductivities are 10 milliSiemens per meter (mS/M). The GPR signals are almost totally attenuated on reaching the 125 mS/M contour. Beyond the plume complex reflection

patterns are returned from the visually rather uniform overburden section. In an attempt to understand the origins of these reflection patterns the radar records were compared to physical property measurements made on cores, specifically core description, dielectric constant measured on 30 cm sections, and grainsize distributions made every 10 cm along the core. The authors conclude that: the core descriptions do not correlate well with radar reflections; that the Time Domain Reflectometry techniques developed to measure dielectric constant on the short cores are not yet good enough to resolve the 2 to 5 percent porosity contrasts that can produce reflections; and that the reflection patterns show some reasonable correlation with grainsize distribution. It is suggested that the dominant reflectors are unconformities or correlative conformities between depositional sequences, interfaces that do not show up well within a 5 cm core. (See also W88-08991) (Author's abstract)
W88-09023

CHARACTERIZATION OF AN ABANDONED WASTE SITE USING PROTON MAGNETOMETRY AND COMPUTER GRAPHICS,
For primary bibliographic entry see Field 5A.
W88-09024

USE OF AN ELECTROMAGNETIC INDUCTION TECHNIQUE IN SUBSURFACE HYDROCARBON INVESTIGATIONS,
For primary bibliographic entry see Field 5A.
W88-09025

USE OF TIME DOMAIN ELECTROMAGNETIC SOUNDINGS FOR MAPPING SEA WATER INTRUSION IN MONTEREY CO., CA.: A CASE HISTORY,
Monterey County Food Control and Water Conservation District, Salinas, CA.
For primary bibliographic entry see Field 5A.
W88-09026

GEOPHYSICAL GROUND WATER MONITORING PROGRAM FOR A SANITARY LANDFILL: IMPLEMENTATION AND PRELIMINARY ANALYSIS,
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 5A.
W88-09027

DETAILED SUBSURFACE MAPPING OF FRACTURE CLOSURE IN A CRYSTALLINE BEDROCK FORMATION,
Buchart-Horn, Inc., York, PA.
For primary bibliographic entry see Field 2F.
W88-09028

WATER MANAGEMENT FOR QUALITY AND QUANTITY: ITS RELATION TO DATA GATHERING AND DATA MANAGEMENT,
For primary bibliographic entry see Field 7C.
W88-09040

ROLE OF THE FISH AND WILDLIFE SERVICE IN WATER-QUALITY MONITORING,
E. T. LaRoe.
IN: Status of the Nation's Water Quality Information Activities. Proceedings of a meeting held May 19-21, 1987, Charlottesville, VA. 1987. p 29-36, 2 fig, 2 ref.

Descriptors: *Fisheries, *Monitoring, *Fish and Wildlife Service, *Pesticides, Water pollution effects, Water quality, Wildlife management, DDT, Dieldrin, Polychlorinated biphenyls, Sampling, Networks, Water analysis, Water quality management, Path of pollutants, Interagency cooperation, Toxaphene, Lipids, Population exposure, Tissue analysis, Fish, Wildlife, Waterfowl, Birds.

The U. S. Fish and Wildlife Service (FWS) research on water quality and contaminants addresses the following four major issues: the cause and effect of contaminants on a variety of fish and wildlife species, modeling the fate and effect of contaminants on populations, development of techniques for detecting and assessing contaminants in biological tissues, with emphasis on new generation contaminants, and monitoring the long-term trends of contaminants in the nations's living resources. The FWS trends monitoring program, started over 20 years ago, is part of the National Pesticide Monitoring Program, now known as the National Contaminant Biomonitoring Program (NCBP). The NCBP detects changes in the levels of contaminants of concern to fish and wildlife. The three monitoring networks address contaminant trends in starlings, ducks, and fish. The fish network includes 112 stations that are sampled on a bi-yearly basis. The Fish Trends Monitoring Network has resulted in five major findings. First, the data from the fish show a statistically significant decline in DDT, polychlorinated biphenyls (PCB's), and dieldrin between 1976 and 1981. Secondly, the monitoring program documents the geographic spread of PCB's and toxaphene during the same period. Third, toxaphene is still spreading geographically. Fourth, the results show the relation of lipids to contaminant concentrations. Lastly, data from the monitoring program cannot be related to human health factors. FWS is now updating its contaminant monitoring program to include new compounds. Issues that the FWS deems appropriate for the involvement of an interagency work group based on its experience over the last 20 years are discussed. (See also W88-09039) (Geiger-PTT)
W88-09042

WATER QUALITY INFORMATION ACTIVITIES OF THE SOIL CONSERVATION SERVICE,
For primary bibliographic entry see Field 7A.
W88-09043

WATER QUALITY INFORMATION ACTIVITIES OF THE GEOLOGICAL SURVEY,
For primary bibliographic entry see Field 7A.
W88-09044

CURRENTLY AVAILABLE GEOPHYSICAL METHODS FOR USE IN HAZARDOUS WASTE SITE INVESTIGATIONS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
R. B. Evans.
IN: Risk Assessment at Hazardous Waste Sites. American Chemical Society, Washington, DC. 1982. p 93-115, 12 fig, 1 tab, 10 ref.

Descriptors: *Geophysics, *Waste dumps, *Hazardous wastes, *Groundwater pollution, Risks, Seismology, Monitoring, Test wells, Land disposal, Waste management, Evaluation, Resistivity, Geological surveys, Waste disposal, Remote sensing, Metal detectors, Magnetometers, Electromagnetic induction, Stratigraphy, Radar.

Monitoring to estimate exposure is essential to risk assessment near sources of exposure. Cost-effective hazardous waste site assessments include three phases: (1) preliminary site assessment, utilizing aerial photography and site inspections; (2) geophysical surveys to pinpoint buried wastes and to help define plumes of conductive contaminants in groundwater; and (3) confirmation of groundwater contamination through monitoring well networks designed on the basis of the geophysical survey. Currently available geophysical methods most applicable in hazardous waste site investigations include metal detectors and magnetometers (useful in locating buried wastes); ground-penetrating radar (useful in defining trench boundaries); electromagnetic induction or EM (useful in surveys of shallow plumes of conductive groundwater contaminants); resistivity (useful in surveys of site stratigraphy and deep groundwater contaminant plumes); and seismic methods (most useful in surveying geologic stratigraphy). (See also W88-09056) (Author's abstract)
W88-09063

REMOTE SENSING AT SAVANNAH RIVER,
J. C. Corey.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-011175. Price codes: A02 in paper copy, A01 in microfiche. 1986. 4 p, 12 fig. Report No. DP-MS-86-155.

Descriptors: *Remote sensing, *Radar, *Hydrologic data collections, *Mapping, *Aerial photography, Thermal imagery, Powerplants, Sensors, Rivers, Topographic mapping, Sniffers, Temperature, Savannah River Plant, South Carolina, Lasers, Spectroscopy.

At the Savannah River Plant, three ground-based remote sensing systems have been used for environmental surveillance: ground penetrating radar, sniffers, and lasers. The ground penetrating radar system may be used to find buried objects. Soil sampling can be used in geophysical explorations, especially in areas where gas has arrived at the soil surface from buried pools. The Savannah River Plant had used a waste site a number of years ago that was covered over with soil. Soil sampling was used to identify the exact location of the waste site. The sniffer technique, which consists of sampling gas from hollow pipes, was used to find where a trench was leaking. Airborne cameras with thermal detection capabilities may be used to identify temperature gradients. Multispectral systems can be useful in exploring the vegetative types in relatively inaccessible areas, such as a swamp near the Savannah River that receives cooling water from the plant's reactor system. A laser system aboard a P-3 aircraft allows topographic mapping of large areas in a short amount of time. Videotaping from helicopters with a thermal imaging camera offers many possibilities for studying biotic and abiotic systems surrounding the powerplant. (Geiger-PTT)
W88-09087

DETERMINING UNCERTAINTY IN PHYSICAL PARAMETER MEASUREMENTS BY MONTE CARLO SIMULATION,
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 5B.
W88-09092

QUANTIFYING PESTICIDE ADSORPTION AND DEGRADATION DURING TRANSPORT THROUGH SOIL TO GROUND WATER,
Cornell Univ., Ithaca, NY. Coll. of Human Ecology.
For primary bibliographic entry see Field 5B.
W88-09093

APPLICATIONS OF SURFACE GEOPHYSICAL METHODS TO GROUND WATER POLLUTION INVESTIGATIONS,
Weston (Roy F.), Inc., Edison, NJ. Raritan Center.
N. De Rose.
IN: Evaluation of Pesticides in Ground Water. American Chemical Society, DC. 1986. p 118-140, 18 fig, 20 ref.

Descriptors: *Pesticides, *Pesticide transport, *Fate of pollutants, *Groundwater pollution, *Monitoring, *Geophysics, *Measuring instruments, On-site investigations, Pollutants, Seismology, Resistivity, Electromagnetic conductivity, Radar, Magnetic studies, Soil properties.

Several surface geophysical survey methods are presented and the principles of operation for each technique discussed. These methods include seismic refraction, resistivity, electromagnetic conductivity, ground penetrating radar and magnetometry. Applications of these geophysical methods to groundwater contamination investigations include; determining lateral and vertical variations in soil, rock and groundwater characteristics; mapping the extent of groundwater contaminants present within aquifers; and locating buried objects. The suitability and potential application of surface geophysical surveys to monitor the migration of field-applied pesticides, and pesticides from waste disposal sites within the unsaturated and saturated zones is also discussed. An example to illustrate the use of geophysical techniques at a hypothetical pesticide

field-application site is outlined. The example details the application of seismic refraction and electromagnetic conductivity techniques to define erratic subsurface conditions at a site where groundwater contamination is suspected. The site is underlain by an unconsolidated deposit of varying thickness and composition which is underlain by cavernous limestone. A groundwater monitoring system is designed based upon interpretation of the geophysical data obtained. By utilizing surface geophysical methods, extensive site coverage can be completed cost effectively and groundwater monitoring systems designed efficiently, thereby increasing the quality and success of site groundwater investigations. (See also W88-09089) (Author's abstract)
W88-09096

ENVIRONMENTAL SAMPLING FOR HAZARDOUS WASTES.
American Chemical Society, Washington, DC. ACS Symposium Series 267. Based on a workshop sponsored by the Committee on Environmental Improvement of the American Chemical Society, The U.S. Environmental Protection Agency, and the University of Nevada-Los Vegas, Los Vegas, Nevada, February 1-3, 1984. 1984. Edited by Glenn E. Schweitzer and John A. Santolucito. 133 p.

Descriptors: *Monitoring, *Statistical methods, *Data acquisition, *Hazardous wastes, *Hazardous materials, *Toxic wastes, *Sampling, Environmental quality, Data interpretation, Fate of pollutants, Sample preservation, Project planning, Water quality, Mathematical studies.

During the past several years, awareness of the need for carefully designed and well-controlled environmental sampling programs has increased. In particular, the rising cost of laboratory analyses of tens of thousands of samples obtained each year at Superfund disposal sites has underscored the importance of collecting only those samples that are truly representative of environmental conditions. Also, ensuring the chemical integrity of samples from collection through analyses has become a paramount concern as monitoring data play a growing role in administrative and judicial decisions. The importance of improved approaches to environmental sampling was documented and several successful field programs including sampling for cyanide in Washington were reviewed. Classical and innovative approaches to using statistics in the design and interpretation of monitoring activities were presented. Guidelines for applying quality assurance procedures in the field were also included. Future research directions were suggested. (See W88-09121 thru W88-09128) (Author's abstract)
W88-09120

HAZARDOUS WASTE: QUESTIONS AND ISSUES FROM THE FIELD,
Environmental Protection Agency, Boston, MA. Region I.
For primary bibliographic entry see Field 5E.
W88-09121

USES OF ENVIRONMENTAL TESTING IN HUMAN HEALTH RISK ASSESSMENT,
Centers for Disease Control, Atlanta, GA.
For primary bibliographic entry see Field 7A.
W88-09122

FIELD MEASUREMENT OF POLYCHLORINATED BIPHENYLS IN SOIL AND SEDIMENT USING A PORTABLE GAS CHROMATOGRAPH,
Environmental Protection Agency, Lexington, MA. Region 1
For primary bibliographic entry see Field 5A.
W88-09124

STATISTICAL METHODS IN ENVIRONMENTAL SAMPLING,
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 7A.
W88-09125

COST-EFFECTIVE TECHNIQUE FOR RECONNAISSANCE EVALUATION OF AQUIFERS,
R. W. Heeley, and S. B. Mabee.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 213-219, 5 fig, 3 tab, 3 ref.

Descriptors: *Cost analysis, *Data acquisition, *Groundwater movement, *Hydrologic data, *Pumping test, Plumes, Tracers, Leaching, Pollutants, Specific capacity, Case studies, Massachusetts, Aquifer characteristics, Aquifer management.

This paper examines two case studies (Sewage disposal in Westford, Massachusetts, and water-supply in Mashpee, Massachusetts) to compare the cost-effectiveness of the specific-capacity technique with that of a conventional pump test in obtaining new data concerning the water-bearing properties of an aquifer as well as the quality of water at various levels within the aquifer. These data may be necessary for the purpose of tracing an existing contaminant plume or for other purposes such as predicting the mounding beneath a leaching field or the upconing of saltwater beneath a pumping well. A cost analysis comparing the two techniques indicated clearly that the specific-capacity method provides a cost-effective means of gathering aquifer property data. Thus, this method provides an inexpensive reconnaissance technique that can be employed to gather aquifer property data during exploratory drilling programs for water-supply, wastewater disposal, solid waste disposal or contaminant tracing studies. It allows the investigator to identify those areas on the site that warrant larger-diameter wells, extended pumping tests or more sophisticated sampling programs in an economical manner. (See also W88-09129) (Friedmann-PTT)
W88-09154

WILL MY MONITORING WELLS SURVIVE DOWN THERE: DESIGN AND INSTALLATION TECHNIQUES FOR HAZARDOUS WASTE STUDIES,
Western Water Consultants, Inc., Sheridan, WY.
H. R. Richter, and M. G. Collentine.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 223-229, 2 tab, 3 ref.

Descriptors: *Design criteria, *Wells, *On-site tests, *Groundwater pollution, *Hazardous wastes, *Installation, *Monitoring, *Observation wells, Casings, Sampling, Cleanup operations, Project planning, Evaluations.

This paper describes various design and installation methods used by the authors to complete monitoring wells and critically evaluates those methods based on site-specific applications. The paper describes design of the monitoring wells, including drilling methods and completion and development practices, decontamination and field examples. Some of the suggested drilling methods are hollow stem auger, air rotary, mud/foam rotary, and backhoe. Factors in determining casing diameter include cost, well development, aquifer testing, sampling, contaminant cleanup, and hydrogeologic environment. A principal controlling factor in decontamination was local climatic conditions. Experience in decontamination of field and drilling equipment at remote project sites under extreme temperature conditions requires driller to have 'extra' supplies on-site so that pre-cleaned equipment is used as each new hole. The authors have found that designing monitoring wells in the office based only on published data does not always meet the objective of the monitoring program. Although the authors believe that in-office design is necessary and a good place to start, it is, however, critical that on-site flexibility in design be employed. (See also W88-09129) (Friedmann-PTT)
W88-09155

ALTERNATIVE WELL SEAL IN HIGHLY MINERALIZED GROUND WATER,
J. A. Senger, and W. M. Perpich.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 230-234, 3 fig, 2 ref.

Descriptors: *Sealants, *Well design, *Monitoring wells, *Salinity, *Mineral water, *Groundwater management, *Monitoring, Brines, Permeability coefficient, Industrial wastes, Water quality, Data acquisitions, Bentonite, Dowell gasket, Solute transport, Contamination, Performance evaluation.

This paper describes the use of the Dowell gasket as a seal for ground-water monitoring wells. Laboratory column tests were conducted to evaluate the effect of the ground-water brine on the bentonite pellets and the Dowell seal ring gasket. The bentonite was adversely affected by the groundwater, showing no appreciable swelling in the brine. However, the Dowell gasket swelled three to four times its original volume in the brine. The coefficients of permeability were determined for the bentonite pellet seal and the Dowell gasket in the brine (0.0000063 cm/sec and 4.5 times 10 to the minus 8th power cm/sec, respectively). Thirteen monitoring wells were installed in the lower silt and glacial till layers of a waste salt pile from an herbicide manufacturing plant, using prefabricated Dowell gaskets. The Dowell gaskets performed satisfactorily. Water-quality data collected from these wells confirmed the bulk soil analyses data regarding the location of the contaminants. However, the Dowell gaskets do contain soluble inorganic and organic compounds. The extent to which this solubility may limit the application of the Dowell gaskets is not known. (See also W88-09129) (Friedmann-PTT)
W88-09156

BACKGROUND GROUND-WATER QUALITY MONITORING: WELL INSTALLATION TRAUMA,
Jordan Gorrill Associates, Portland, ME.
S. E. Walker.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 235-246, 6 fig, 2 tab, 12 ref.

Descriptors: *Chemistry of groundwater, *Well design, *Wells, *Monitoring wells, *Groundwater management, *Aquifer management, *Observation wells, *Monitoring, *Installation, *Data interpretation, Aeration, Oxidation-reduction potential, New England, Construction, Geology, Hydrogen ion concentration, Sealants, Backfills, Well water.

The increased use of guidelines for groundwater quality monitoring wells has led to the continued improvement these wells. However, even with a high level of care given to their installation, many monitoring wells yield anomalously variable analytical results for considerable time periods following installation. This paper presents and reviews the installation and chemical analysis data from 20 background monitoring wells at six locations in northern New England. Several of the factors considered in this review are well design and construction, geology, hydraulic conditions, and physicochemical processes. The data were drawn from groundwater quality monitoring projects conducted by the E.C. Jordan Co., during the design and permit application of phases of ash, sludge and mine tailing disposal projects. From the conditions observed at the sites described in this paper, the following conclusions were drawn: (1) normally employed monitoring well installation procedures can cause substantial hydrogeochemical trauma; (2) the magnitude of installation trauma is related to physico-chemical differences between the natural ground water and substances introduced during well installation (drilling fluids, seals and backfills); (3) hydraulic stressing of seals and backfill can cause passage of pH-altering substances into the well cavity; (4) introduction of air into the well water can significantly alter the natural reduction-oxidation potential (Eh) of the ground water. Some of the recommendations offered by the author to minimize installation trauma are: minimize or eliminate the introduction of water in

installing the well; do not use bentonite or other drilling fluids unless absolutely needed; if water is needed, attempt to use water with a pH similar to that anticipated of the natural ground water, based on localized knowledge (soil conservation services, geological survey, etc.); and look for changes in ratios between geochemically related analytes (Mg/Ca, Mn/Fe, Cu/Pb, etc.). (See also W88-09129) (Friedmann-PTT)
W88-09157

TECHNIQUE FOR RENOVATING CLOGGED MONITOR WELLS,
W. H. McTigue, and R. G. Kunzel.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 247-250, 3 fig, 4 ref.

Descriptors: *Renovation, *Wells, *Monitoring wells, *Cleaning, *Observation wells, *Monitoring, *Maintenance, *Mechanical failure, Remedies, Cleaning, Silt, Well casings, Sand filters, Groundwater movement, Jetting, Bentonite.

This paper describes a technique for renovating 2-inch PVC monitor wells that have been clogged by intrusion of silt from the surrounding soil and that have, in this case, been cross-contaminated by bailer sampling. The technique selected consisted of the installation of a properly filtered gas-displacement sampler inside the 2-inch PVC casing and screen of the existing monitor wells. The first step in the procedure was thorough cleaning of each monitor well using a water jetting system, using clean water from the municipal system, which was not recirculated after being introduced into the well. After the intruded silt had been washed out of the casing and screen of each well, and after the jetting water returned consistently clear, the jetting tools were withdrawn from the well casing, making sure that the water level in the casing was not allowed to drop during the withdrawal. A gas-displacement sampler with a porous polyethylene tip section and rigid PVC riser pipe was inserted into the clean monitor well and screen. The outside diameters of sampler and riser pipe were 1 1/2 and 1 inch, respectively. The sampler unit itself was approximately 16 inches in length. After the sampler unit was carefully centered in the well, filter sand was poured slowly into well casing to allow the movement of ground water into the monitor well and into the gas drive sampler while excluding the fine particles now lodged in the original gravel pack. A seal of bentonite pellets was placed in the well casing at the top of the filter sand column. The remainder of the well casing was then filled with readily available material to complete the installation. After installation, the gas-displacement sampler was operated as a pump to extract residual wash water in the filter sand and to ensure that the entire system was purged and refilled with natural ground water. (See also W88-09129) (Friedmann-PTT)
W88-09158

BORE-VOLUME PURGING TO IMPROVE MONITORING WELL PERFORMANCE: AN OFTEN-MANDATED MYTH,
T. Giddlings.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 253-256, 4 fig.

Descriptors: *Aquifer management, *Boreholes, *Maintenance, *Monitoring, *Purging, *Observation wells, *Unconsolidated aquifers, Bedrock aquifers, Cleaning, Sampling, Water sampling.

Problems associated with bore volume purging are addressed. The process can alter the aquifer-quality water, masking of the parameters to be monitored or diluting the contaminant to levels below detection. These problems are not limited to either low- or high-yield monitoring wells and are found in both unconsolidated and bedrock aquifers. While it is generally agreed that the stagnant water must be removed from the well bore in order to sample representative, aquifer-quality water, there can be established no specific number of well-bore volumes of water that must be removed from a well in order to provide a satisfactory sample. This is because the response of each monitoring well will depend on the aquifer transmissivity and storage coefficients, the stratigraphy penetrated by the well and the specific well design. Sometimes, certain contaminants are best sampled without any purging of the well bore at all. Removal of a set number of well-bore volumes of water, whether adjusted for well yield or not, can often lead to misrepresentative samples that are insensitive due to dilution of contaminants, masking the chemical constituents or other alteration of the aquifer-quality water during purging. While in most cases something must be done instead of sampling the stagnant water in the well bore, the controlled pumping of the well while monitoring a few parameters in the field to determine when aquifer-quality water is pumped will provide far better results than purging the same number of bore-volumes from each well. (See also W88-09129) (Friedmann-PTT)
W88-09159

LABORATORY INVESTIGATION OF THE PURGING BEHAVIOR OF SMALL-DIAMETER MONITORING WELLS,
J. P. Unwin, and D. Huis.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 257-262, 6 fig, 3 ref.

Descriptors: *Hydraulic engineering, *Purging, *Well pumps, *Wells, *Monitoring wells, *Observation wells, *Monitoring, *Well casings, Evaluations, Seals, Stagnant water, Pumping.

Hydraulic aspects of the purging process under laboratory-controlled conditions. The primary objective of the experiment was to examine the effect of pumping water from near the water surface within the well casing (surface purging) and to make a comparison with the effect of pumping from a further submerged position. A secondary objective was to evaluate the effect of pumping rate on the purging behavior. The results of this research showed that: (1) purging accomplished by pumping from near the water surface within the well casing is the most reliable way to ensure complete removal of stagnant water within a 2-inch well casing; (2) removal of about seven bore volumes by surface pumping is sufficient to cause virtually complete purging of a 2-inch casing; (3) purging behavior during surface purging is independent of pumping rate over the range of rates examined (0.15 gpm to 5 gpm); (4) pumping from a submerged location far below the water surface introduces uncertainty as to when purging can be considered complete due to possible downward migration of water form above the pump inlet. Such downward migration may be expected even in the absence of drawdown effects. The effect is exacerbated by a high pumping rate; (5) a close-fitting baffle above the pump inlet is not effective in preventing the intake of stored water during subsurface purging. A tight seal above the pump inlet (e.g., an inflatable packer) may prevent downward migration of stored water. (See also W88-09129) (Friedmann-PTT)
W88-09160

CHEMICAL PROBLEMS IN GROUND-WATER MONITORING PROGRAMS,
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
For primary bibliographic entry see Field 7A.
W88-09161

DEALING WITH THE PROBLEM OF OBTAINING ACCURATE GROUND-WATER QUALITY ANALYTICAL RESULTS,
For primary bibliographic entry see Field 7A.
W88-09162

INACCURATE WATER-QUALITY DATA IN GROUND-WATER STUDIES,
Western Water Consultants, Inc., Sheridan, WY.
For primary bibliographic entry see Field 7A.
W88-09163

USE OF GEOPHYSICAL TECHNIQUES TO DELINEATE GROUND-WATER CONTAMINATION,
For primary bibliographic entry see Field 7A.
W88-09164

REFINEMENT OF THE SHALLOW SEISMIC REFLECTION TECHNIQUE IN DETERMINING SUBSURFACE ALLUVIAL STRATIGRAPHY,
Ecology and Environment, Inc., Kansas City, KS.
D. A. Kopsick, and T. W. Stander.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 301-306, 5 fig, 1 tab, 2 ref.

Descriptors: *Seismic properties, *Stratigraphy, *Seismology, *Alluvial aquifers, *Geophysics, *Hydrologic data collections, Groundwater flow, Groundwater management, Monitoring, Data acquisition, Subsurface water, Geology.

This paper discusses the application of shallow seismic reflection which can identify subsurface structures as shallow as 7 meters. Subsurface data at depths of 7 to 30 mm were discernible on a seismogram. The impact from a 0.223 caliber rifle bullet generated frequencies over 400 Hz, in comparison to frequencies below 100 Hz generated by conventional seismic energy sources. These higher frequencies allow for detection of reflectors at very shallow depths, with increased resolution of the sedimentary beds. This technique can be very useful to the hydrogeologist in characterizing alluvial environments for the purposes of groundwater monitoring or ground-water renovation. The combination of exploratory drilling and seismic reflection, usipg the parameters described in this paper, yields useful data on the shallow subsurface structure and stratigraphy. Because this technique, as presently developed, cannot determine specific permeabilities or porosities, borehole data is necessary in order to quantify these parameters. (See also W88-09129) (Friedmann-PTT)
W88-09165

APPLICATION OF GEOPHYSICAL TECHNIQUES AS A SITE SCREENING PROCEDURE AT HAZARDOUS WASTE SITES,
Environmental Protection Agency, Atlanta, GA. Region IV.
A. S. Hitchcock, and H. D. Harman.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 307-312, 5 fig, 9 ref.

Descriptors: *Sampling, *Wells, *Landfills, *Waste dumps, *Groundwater pollution, *Aquifer management, *Geophysics, *Site selection, Monitoring, Leachates, Economic aspects, Case studies, Cost analysis, Geohydrology, Contracts, Resistivity, Magnetometry.

This paper describes several case studies where geophysical techniques were applied to better define potential ground-water contamination problems. The case histories illustrate typical uses of such techniques in the southeastern U.S. EPA Region IV utilized the capability of the Field Investigation Team contract to conduct these investigations. These Studies consisted of an initial evaluation of site history, waste analyses and hydrogeology. Few control wells were drilled during these studies. Resistivity data interpretations were mainly based on existing subsurface data and similar experiences at other sites. Most surveys were completed in two to four days with crews of two or three people. As a means of preliminary leachate monitoring and location waste sources, resisitivity and magnetometry have proven to be cost-effective site screening techniques. In contrast to conventional drilling and sampling techniques, it can be shown that the use of geophysics allows a manyfold savings in time, dollars and resources. The drilling rig contract requirements alone repre-

sent a three- to four-week time delay, while the time required for a geophysical investigation from the planning stage to the completion of the final report is in the range of four to five weeks. In time savings alone, the advantage in using geophysical techniques for screening studies is apparent. (See also W88-09129) (Friedmann-PTT)
W88-09166

GROUND-WATER MONITORING IN CLAY-RICH STRATA - TECHNIQUES, DIFFICULTIES AND POTENTIAL SOLUTIONS,
Becon Construction Co., Houston TX. Mining Services Group.
For primary bibliographic entry see Field 7A.
W88-09170

FIELD APPLICATIONS OF CHEMICAL TIME-SERIES SAMPLING,
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
J. F. Keely, and F. Wolf.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 373-381, 8 fig, 2 tab, 17 ref.

Descriptors: *Groundwater pollution, *Aquifer management, *Sampling, *Time series analysis, *Path of pollutants, Tracers, Data acquistions, Data interpretation, Sampling, Hydraulic profiles, Tracers, Pumping.

This paper describes the methodology and sample applications of chemical time-series sampling of groundwater contamination. The use of time-series sampling is quite similar to the use of tracer tests to gain insights into preferential paths of contaminant movement. There are sound benefits to incorporation of successive pumped samples in ground-water contamination investigations, including temporal sampling efficiency. Also, as this paper shows, concurrent hydraulic testing not only yields important information about aquifer parameters, but may be readily adapted to enhance the use of time-series analyses; e.g., purposeful hydraulic interference can be used to isolate and locate a contaminant source. (See also W88-09129) (Friedmann-PTT)
W88-09173

VELOCITY PLOTS AND CAPTURE ZONES OF PUMPING CENTERS FOR GROUND-WATER INVESTIGATIONS,
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
J. F. Keely, and C. F. Tsang.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 382-395, 14 fig, 4 tab, 13 ref.

Descriptors: *Plumes, *Groundwater pollution, *Data interpretation, *Pumping plants, *Groundwater movement, *Velocity distribution, Computers, Capture zone, Data acquistion, Distribution patterns, Mapping.

This paper describes several easily mastered methods for rapid estimation of the impact of pumping center on nearby contaminant plumes. Data were appropriately corrected to account for the different sources of data variability. Data from pumping (water-supply) wells are often gathered during ground-water contamination investigations to augment special monitoring wells and to estimate the effectiveness of remedial actions. Because the interpretation of these data requires an understanding of the areal limits of the zone of the aquifer actually yielding waters to a pumping well (the capture zone), it is useful to construct velocity distribution plots. While manual plots are easily constructed for a single well, use of computerized codes is much more efficient for more complex situations. Such codes can be devised to show not only the spatial distribution of contaminants, but also the contaminant concentration history at selected points. Use of such plots can help the field investigator select the most appropriate solutions to pollution problems. (See also W88-09129) (Friedmann-PTT)
W88-09174

DIRECT MEASUREMENT OF GASOLINE FLOW,
K-V Associates, Inc., Falmouth, MA.
W. B. Kerfoot, and V. Massard.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 396-401, 9 fig, 5 ref.

Descriptors: *Groundwater pollution, *Wells, *Flow meters, *Gasoline, *Path of pollutants, *Well screens, Flow rates, Thermal conductivity, Aquifer management, Calibrations, Hydrogeology, Darcys law, Geohydrology, Graphical methods.

Direct measurement of gasoline flow on top of groundwater provides rapid information on direction and rate of movement. This paper describes direct measurement, which can be used for calibration if a sufficient volume of strata is available. Careful attention should be paid to well construction and screen selection to optimize accuracy of direction and rate determinations. Slotted well screens either four or more rows show a significant improvement in accuracy of direction compared with three or less rows. Small slot width not only greatly restricts flow rate, but sizes less than 0.010 inch may swell shut and eliminate flow. The time to peak is similar to water for groundwater flow meter probes. Sensitivity with gasoline as the liquid phase was found to be about one-half that of water. This appears due to the lower thermal conductivity of gasoline compared to water, although the heat pulse travels principally through glass beads. Using a three-dimensional graphic display of the Darcian variable, the site hydrogeological characteristics can be visually depicted. (See also W88-09129) (Friedmann-PTT)
W88-09175

TWO CASE HISTORIES ON THE DESIGN AND PUMP TESTING OF INDIVIDUAL AQUIFERS WITH DUAL COMPLETED WELLS,
Blatchley Associates, Inc., Denver, CO.
For primary bibliographic entry see Field 7A.
W88-09179

MEASUREMENT AND PREDICTION OF THE EFFECTIVENESS OF OIL SPILL CHEMICAL DISPERSANTS,
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
D. Mackay, A. Chau, K. Hossain, and M. Bobra.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 38-54, 2 fig, 4 tab, 17 ref.

Descriptors: *Oil spills, *Cleanup operations, *Chemical treatment, *Dispersants, *Water pollution treatment, Simulation analysis, Model studies, Mathematical models, Oil, Viscosity, Salinity.

Recent developments in effectiveness testing of dispersants are discussed, with emphasis on the Mackay-Nadeau-Steelman laboratory test. A novel flume test system is described in which an attempt was made in the laboratory to simulate a sea test involving continuous application by boat. Some recent findings of test programs are discussed and a detailed mechanism proposed for the dispersion process. It is proposed that a mathematical model be sought to express effectiveness as a function of the volumes of oil, water, and dispersant, oil viscosity, water salinity, and application method. It is suggested that this model could form the basis of a procedure for correlating effectiveness and linking laboratory tests to application conditions at sea. (See also W88-09183) (Author's abstract)
W88-09187

STATUS OF THE WARREN SPRING LABORATORY'S ROLLING FLASK TEST,
Dasic International Ltd., Romsey (England).
For primary bibliographic entry see Field 5G.
W88-09188

VIEW OF THE MACKAY AND LABOFINA LABORATORY TESTS FOR ASSESSING DISPERSANT EFFECTIVENESS WITH REGARD TO PERFORMANCE AT SEA,
British Petroleum Co. Ltd., Sunbury-on-Thames (England). BP Research Centre.
For primary bibliographic entry see Field 5G.
W88-09189

USE OF REMOTE SENSING IN THE DETERMINATION OF DISPERSANT EFFECTIVENESS,
Esso Resources Canada Ltd., Calgary (Alberta). Research Dept.
For primary bibliographic entry see Field 5G.
W88-09194

EVALUATION PROGRAM FOR AERIALLY APPLIED DISPERSANTS,
Government of Canada, Ottawa (Ontario).
For primary bibliographic entry see Field 5G.
W88-09195

RECOMMENDED METHODS FOR TESTING THE FATE AND EFFECTS OF DISPERSED OIL IN MARINE SEDIMENTS,
Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.
J. W. Anderson, J. R. Vanderhorst, S. L. Kiesser, M. L. Fleischmann, and G. W. Fellingham.
IN: Oil Spill Chemical Dispersants: Research, Experience, and Recommendations. A Symposium Sponsored by ASTM Committee F-20 on Hazardous Substances and Oil Spill Response, West Palm Beach, Florida, October 12-13, 1982. ASTM, Philadelphia, Pennsylvania. 1984. p 224-238, 2 fig, 6 tab, 11 ref. Exxon Production Research Co. Contract No. 2311204123.

Descriptors: *Water pollution effects, *Fate of pollutants, *Dispersants, *Oil spills, *Marine environment, Sediments, Marine sediments, Oil pollution, Benthic fauna, Clams.

Tests have been conducted to determine the extent of dispersed oil sorption on sediments and retention of this association when seawater is flushed through the substrate. Sediment beds were prepared where dispersed oil in seawater was allowed to percolate down through the sand. Water concentrations of dispersed oil were determined before and after percolation. Distribution of oil in sediments was shown to be very patchy and not suitable for quantitating effects on benthic species. Eighty-three percent of the oil remained in the top 3 cm during this process. Additional tests in special cores showed that sediments containing dispersed oil would release about 40% of the oil when seawater flowed from the bottom of the core up through the bed of sand. Based on the fact that most of the dispersed oil is held in the 3 cm of substrate when water is drained completely through the sediment, it is recommended that exposure systems be designed with a layer (2 to 3 cm) of contaminated substrate on top of clean sediment. Fiberglass trays (with mesh bottoms) were prepared in this manner and exposures initiated in both subtidal and intertidal areas in Sequim Bay, Washington. The alterations in hydrocarbon component composition during the 2-yr exposure periods are described. Biological responses measured in these studies were the growth of small clams and the recruitment of multiple benthic species. Significant reductions were observed in clam growth in oil-contaminated sediments. In studies in Year 1 (intertidal zone), the difference in effects on recruitment of benthic species attributable to the two treatments (dispersed and undispersed oil) was not significant but in Year 2 studies (subtidal zone), more severe effects on recruitment resulted from chemically dispersed oil. (Author's abstract)
W88-09199

UTILIZATION OF SELECTIVE DISSOLUTION METHODS FOR ASSESSING 137-CS MOBILITY AND BIOAVAILABILITY,
M. R. Noll, and P. M. Bertsch.
IN: Annual Report of Ecological Research at the Savannah River Ecology Laboratory. DOE Report SRO--819-17, (1986). p 12-16, 3 fig, 1 tab.

Descriptors: *Path of pollutants, *Fate of pollutants, *Cesium radioisotopes, *Chemical analysis, *Sequential selective dissolution, Ammonium chloride, Steel Creek, South Carolina, Nuclear industry, Chemical reactions, Oxides, Organic matter, Peroxide.

The establishment of L-Lake for receiving thermal effluent from the newly reactivated L-Reactor has raised some concern about possible remobilization of 137-Cs from the Steel Creek floodplain sediments. To assess the potential for 137-Cs remobilization and bioavailability under specific environmental conditions, information on cesium distribution among the various solid phase components is required. The objective of this investigation was to develop a method for estimating the various chemical forms of 137-Cs in sediments employing a sequential selective dissolution (SSD) technique that could be utilized in assessing potential bioavailability. Several methods were combined to form six different SSD schemes. Exchangeable 137-Cs was extracted in all schemes with calcium acetate to estimate planar site (nonspecifically adsorbed) Cs(CaOAc) followed by ammonium chloride, to estimate available interlayer edge and wedge zone Cs, which is not exchangeable by larger hydrated cations (NH4Cl). Oxides were then removed by either hydroxylamine or dithionite citrate (DCB). Organic matter was oxidized with acidified 30% peroxide, unacidified 30% peroxide, sodium hypochlorite, or sodium pyrophosphate. The residual 137-Cs was that which remained associated with the solid phases following all extractions. (See also W88-09211) (Lantz-PTT)
W88-09213

REMOTE SENSING: METHODS AND APPLICATIONS,
R. M. Hord.
John Wiley and Sons, New York. 1986. 362 p.

Descriptors: *Image processing, *Remote sensing, *Sensors, *Data acquisition, Radar, Mathematical studies, Algorithms, Meteorology, Geohydrology, Agriculture, Oceanography, Satellite technology, Mappers, Computers.

Drawn from a wide range of papers, reports and government documents, this book examines the state-of-the-art in remote sensing. After presenting an overview and summary, the material is organized around three broad subjects: sensors, processing and analysis techniques, and applications; and each of these is covered in an extensive chapter. In Chapter 1, the book's emphasis on civilian spaceborne data sources is established, with in-depth coverage of radar imaging, coastal zone color scanners, thematic mappers, and return beam vidicon equipment. Chapter 2 brings together algorithms and other methods for converting bits into pictures, extracting features of the patterns in those pictures, and evaluating results. Chapter 3 describes the uses of remote sensing technology in meteorology, geology, agriculture, and oceanography. The Appendix provides a list of pixel values for a window of a Landsat Multispectral Scanner (MSS) image so that the reader can try some processing on real data using a personal computer. (Lantz-PTT)
W88-09237

PROCEEDINGS OF THE SIXTH NATIONAL SYMPOSIUM AND EXPOSITION ON AQUIFER RESTORATION AND GROUND WATER MONITORING.
National Water Well Association, Dublin, OH.
For primary bibliographic entry see Field 5G.
W88-09283

COMPARISON OF THE EFFECTS OF ROTARY WASH AND AIR ROTARY DRILLING TECHNIQUES ON PUMPING TEST RESULTS,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 2F.
W88-09285

COMPARISON OF VADOSE MONITORING PROCEDURES,
Alabama Univ., University.
For primary bibliographic entry see Field 2F.
W88-09288

EVALUATING FLUSHING AS A REMEDIAL ALTERNATIVE USING SOIL COLUMN TESTS,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
L. R. Penniman.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 62-70. 3 fig, 2 tab, 7 ref.

Descriptors: *Water pollution control, *Hazardous wastes, *Landfills, *Flushing, *Analytical methods, *Soil columns, *Groundwater monitoring, *Groundwater pollution, *Leachates, Soil properties, Testing, Design criteria, Aquifers, Groundwater management, Effluents, Groundwater.

The procedure for conducting a soil column test is described with respect to utilizing this technique for evaluating soil flushing for remediation of hazardous waste sites. Technical factors that should be considered prior to selection of flushing as a potential alternative include the soils hydraulic loading and desorptive capacities and the ability of the leachate to be collected. Test design parameters include selection of representative soils, selection of an appropriate transport fluid and test apparatus. Case history results of a soil column test conducted on three coarse-grained soils collected from a hazardous waste site showed significant reduction of effluent concentrations after displacement of 150 pore volumes. (See also W88-09283) (Author's abstract)
W88-09289

USE OF STATIC SOIL VAPOR COLLECTORS TO IDENTIFY SUBSURFACE CONTAMINATION IN SOUTHERN CALIFORNIA GROUND WATER BASINS,
Mills (William B.) and Associates, Placentia, CA.
For primary bibliographic entry see Field 5A.
W88-09290

ALTERNATIVE METHOD OF LYSIMETER AND SILICA FLOUR PACK PLACEMENT IN DEEP BOREHOLES,
LeRoy Crandall and Associates, Glendale, CA.
For primary bibliographic entry see Field 2F.
W88-09291

EFFECTS OF FILTRATION METHOD AND SAMPLING DEVICES ON INORGANIC CHEMISTRY OF SAMPLED WELL WATER,
RMT, Inc., Madison, WI.
For primary bibliographic entry see Field 5A.
W88-09299

FIELD EVALUATION OF GROUND WATER SAMPLING DEVICES FOR VOLATILE ORGANIC COMPOUNDS,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
For primary bibliographic entry see Field 5A.
W88-09300

SUB-LINER GROUND WATER MONITORING AT A LARGE LINED LANDFILL,
Golder Associates, Mississauga (Ontario).
For primary bibliographic entry see Field 7A.
W88-09301

GROUND WATER SAMPLING WITHOUT WELLS,
Montgomery (J.M.) Consulting Engineers, Inc., Irvine, CA.
For primary bibliographic entry see Field 5A.
W88-09302

USE OF ONSITE ANALYTICAL LABORATORY INSTRUMENTATION TO DETERMINE THE EXTENT OF CONTAMINATION AT A HAZARDOUS WASTE SITE,
Camp, Dresser and McKee, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5A.
W88-09303

RAPID GROUND WATER ASSESSMENT USING A MOBILE LABORATORY,
O.H. Materials Corp., Findlay, OH.
For primary bibliographic entry see Field 5A.
W88-09304

RATIONALE FOR FILTRATION OF GROUND WATER SAMPLES,
Geraghty and Miller, Inc., Syosset, NY.
O. C. Braids.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 292-294.

Descriptors: *Filtration, *Groundwater monitoring, *Analytical methods, *Sampling devices, *Water analysis, Measuring instruments, Groundwater pollution, Chemical analysis, Monitoring wells, Water quality, Aquifers, Gases, Organic compounds, Radioisotopes, Dissolved solids, Suspended solids.

The issue of filtration of groundwater samples is integral to discussions of proper protocol in groundwater sampling. Some workers believe that filtration is essential to the preparation of a water sample in order to get a representative and accurate analysis, whereas others are equally convinced that filtration will deleteriously effect the water sample and lead to difficulties with the data acquired from it. Each side of this issue has merit because the reasons for the groundwater analysis vary and the objectives in the analytical program also differ. There are legitimate situations in which a groundwater sample should not be filtered before it is analyzed for its chemical constituents in the laboratory and there are circumstances dictating that an accurate analysis is only obtained when filtration is accomplished. Although filtration in this context is filtration through a 0.45 micron pore-size membrane, the same principles apply if the filtration medium is glass fiber or paper. Frequently, practical limitations of time and sample characteristics dictate the use of glass fiber or paper as prefilters before the final membrane step. In dealing with the subject of filtration, one must address the water-quality parameters that could be affected either by the act of filtration or by the failure to filter. The effect of filtration is discussed in relation to the following parameters: dissolved gases, dissolved metals, suspended matter, iron precipitates, radioactive gases, radioisotopes associated with suspended solids, and volatile organic compounds. (See also W88-09283) (Alexander-PTT)
W88-09305

SHOULD GROUND WATER SAMPLES FROM MONITORING WELLS BE FILTERED BEFORE LABORATORY ANALYSIS, YES AND NO,
New Jersey Dept. of Environmental Protection, Trenton.
For primary bibliographic entry see Field 5A.
W88-09306

POSITIVE ASPECTS OF SAMPLE FILTRATION,
Jordan (Edward C.) Co., Inc., Portland, ME.
For primary bibliographic entry see Field 5A.
W88-09307

RATIONALE FOR SCREEN LENGTH SELECTION AND PLACEMENT,
Environmental Protection Agency, Denver, CO. Region VIII.
For primary bibliographic entry see Field 7A.
W88-09309

REVIEW OF MATERIALS USED IN MONITORING AND MONITORING WELL CONSTRUCTION,
Waste Management, Inc., Oak Brook, IL.
For primary bibliographic entry see Field 6E.
W88-09310

HOW DRILLING FLUIDS AND GROUTING MATERIALS AFFECT THE INTEGRITY OF GROUND WATER SAMPLES FROM MONITORING WELLS,
Geraghty and Miller, Inc., Lawrence, KA.
J. P. Gibb.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 340-346. 11 ref.

Descriptors: *Water analysis, *Sampling, *Drilling, *Grouting, *Groundwater monitoring, *Monitoring wells, *Water quality, Water chemistry, Groundwater pollution, Chemical analysis, Groundwater management, Geohydrology, Chemical interference, Hydrology, Aquifers, Bentonite, Groundwater.

The use of drilling fluids in monitoring wells should be curtailed whenever possible. Migration of bentonite or even 'clean water' into the aquifer materials disturbs the subsurface environment and creates chemical and biological conditions that have the potential for altering water quality in the immediate vicinity of the well and the area impregnated. Due to the limited area of influence experienced during development of monitoring wells, drilling fluids seldom are removed to the extent that they will not cause 'well trauma.' Similarly, the improper placement of well sealing materials often results in these materials being in the flow path to the well or in such close proximity that they also chemically interfere with the quality of water collected from the well. The inability to measure in-situ groundwater quality conditions prohibits field documentation or measurement of these types of chemical interferences. The sparsity of field documentation or evidence should not be used as an excuse to overshadow common sense and laboratory evidence that clearly indicates the potential for chemical interference from drilling fluids and grout materials. (See also W88-09283) (Alexander-PTT)
W88-09311

EFFECTS OF GROUTS, SEALANTS, AND DRILLING FLUIDS ON THE QUALITY OF GROUND-WATER SAMPLES,
Environmental Protection Agency, Washington, DC. Office of Waste Programs Enforcement.
K. V. B. Jennings.
IN: Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring. Columbus, Ohio. May 19-22, 1986. National Water Well Association, Dublin, OH. 1986. p 347-355. 9 ref.

Descriptors: *Drilling, *Grouting, *Groundwater monitoring, *Monitoring wells, *Water quality, Groundwater management, Hydrogen ion concentration, Guar gum, Bentonite, Chemical oxygen demand, Sulfates, Chlorides, Water chemistry, Groundwater pollution, Chemical analysis, Geohydrology, Hydrology, Aquifers, Groundwater.

Representative samples of groundwater quality are difficult to obtain and subject to a variety of influences. Potential sources of impact on sample quality are grouts and sealants, and drilling fluids. Grouts and sealants may either invade the formation and filter pack and elevate pH, or if improperly installed, provide an avenue for sample contamination from overlying units or the surface. Drilling fluids, most commonly guar gum and bentonite suspensions, have been shown to elevate chemical oxygen demand, sulfate and chloride concentrations. Additionally, the large number of potential additives comprise a list of potential contaminants of the groundwater system. Proper attention to procedure must be employed to minimize the potential impacts of grouts and sealants and drilling fluids on the operation of monitoring systems. (See also W88-09283) (Author's abstract)
W88-09312

METHOD FOR CHARACTERIZING VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN SHALLOW SOILS,
Kennedy/Jenks/Chilton, Irvine, CA.
For primary bibliographic entry see Field 5A.
W88-09325

INSTRUMENTATION OF PORE PRESSURE AND SOIL WATER SUCTION,
Bristol Univ. (England). Dept. of Geography.
M. G. Anderson, and P. E. Kneale.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 77-112, 27 fig, 5 tab, 44 ref.

Descriptors: *Measuring instruments, *Pore pressure, *Soil water, Piezometers, Tensiometers, Sensors, Instrumentation, Monitoring, Data acquisition, Groundwater, Geohydrology.

Slope hydrology is an element of slope instability that is reflected explicitly in slope stability models, or is implicitly required in the examination of longer term hillslope development. In many slope stability problems and in many materials (especially residual soils) uncertainties relating to the strength parameters of a soil are perhaps similar to the difficulties of predicting pore pressure or suction values for stability analysis. While this factor is of critical, and frequently underrated importance, it must be appreciated that pore pressure/suction monitoring is undertaken for perhaps four primary reasons: (1) To calibrate stability analysis models; (2) To provide a means of estimating the worst groundwater condition a site might experience; (3) To provide initial results as a prelude to full site instrumentation; and (4) To identify the dominant groundwater/soil water processes. Instrumentation selection, installation, and monitoring is thus a major element in site investigation work. Of course, in many investigations it is necessary to undertake more than one of the above objectives of pore pressure monitoring simultaneously, due to cost constraints. These objectives may potentially interact and, bearing in mind the particular significance of pore water conditions, it is important that a sound review is provided of available instrumentation. This chapter reviews instrumentation in three classes: piezometer systems, tensiometers, and sensors for suction measurement in excess of 90 kPa. (See also W88-09334) (Lantz-PTT)
W88-09337

CHEMICAL ANALYSIS OF WATER: GENERAL PRINCIPLES AND TECHNIQUES,
Water Research Centre, Medmenham (England). Medmenham Lab.
D. T. E. Hunt, and A. L. Wilson.
The Royal Society of Chemistry, Burlington House, London, England. 1986. 683 p.

Descriptors: *Water analysis, *Chemical analysis, *Chemical properties, *Data interpretation, Sampling, Water quality.

This book is intended to deal solely with the analysis of those aqueous solutions to which the terms 'water' is commonly applied. Thus, potable waters and naturally-occurring fresh waters are included, but trade effluents, sewage, industrial wastes, etc., are generally excluded. In establishing a program of sampling and analysis, it is useful to consider the total process as composed of a number of sequential stages. The sequential approach adopted here provides a reasonable framework in which all the factors of interest can be discussed. Section 2 discusses the stage where decisions concerning the analytical information required for the water of interest are discussed. Section 3 considers factors affecting the spatial and temporal variability of water quality. Section 4 describes the nature of errors in analytical results and also presents some simple statistical ideas and techniques of value in quantifying these errors, while section 5 discusses the sources, estimation, and control of the bias of analytical results in individual laboratories. Section 6 deals in depth with the estimation and control of the precision of analytical results in individual laboratories, and section 7 describes a detailed procedure for ensuring that all laboratories of a group achieve a specified accuracy. Section 8 considers how the discussion in sections 4 to 6 bears on the way in which routine analytical results should be reported. The remaining five sections discuss the factors to be considered in choosing analytical methods, problems commonly met in analysis, and the advantages vs. disadvantages of various laboratory techniques and computer methodologies. (Lantz-PTT)
W88-09355

SAMPLING AND ANALYSIS OF RAIN.
American Society for Testing and Materials, Philadelphia, PA.
A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. 99 p. Edited by S. A. Campbell.

Descriptors: *Water analysis, *Rain, *Chemical analysis, *Sampling, *Acid rain, Hydrogen ion concentration, Workshops, Precipitation.

The many laboratories measuring precipitation parameters throughout the world attest to the importance of this activity. Participating organizations range from major networks, which collect and process thousands of samples per year, to local college, university, and state laboratories, which may process 10 to 100 samples per year. Research scientists are conducting extensive, sophisticated, multisite studies of the composition of storm water using coulometric titration and mass spectrography, while in Vermont members of an extensive voluntary network of citizens are determining rainwater acidity using pH paper. Voluntary standardization of some of the collection and measurement techniques would seem to have many advantages. Agreements among major networks to store precipitation samples and to conduct certain analyses using the same predetermined and tested procedures would radically improve data comparability. Perceiving a need for standard methods for deposition measurement, ASTM Committee D-22 on Sampling and Analysis of Atmospheres recommended practices for the collection and analysis of precipitation and formulated appropriate standard methods. ASTM convened a one day conference and workshop on Sampling and Analysis of Rain on October 7, 1981 to assess the need for and interest in standards development. At the conference, invited authors described the processes leading to acidic precipitation, some techniques used to collect and analyze rain, and quality assurance programs currently used by major acid precipitation measurement networks. This book is a compilation of these papers. (See W88-09388 thru W88-09396) (Lantz-PTT)
W88-09387

SAMPLING, ANALYTICAL, AND QUALITY ASSURANCE PROTOCOLS FOR THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 7A.
W88-09395

MANUAL OF GROUND-WATER QUALITY SAMPLING PROCEDURES,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 5A.
W88-09401

INSTRUMENTATION: HANDBOOK FOR WATER AND WASTEWATER TREATMENT PLANTS,
EMA, Inc., St. Paul, MN.
For primary bibliographic entry see Field 5D.
W88-09403

PRINCIPLES OF ENVIRONMENTAL SAMPLING.
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 7A.
W88-09415

OVERVIEW OF THE SAMPLING PROCESS,
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
M. J. Barcelona.
IN: Principles of Environmental Sampling. American Chemical Society. 1988. p 3-23, 3 fig, 2 tab, 95 ref.

Descriptors: *Pollutant identification, *Sampling, *Water sampling, *Water analysis, Sample preparation, Sample preservation, Field tests, Chemical analysis, Errors.

Meaningful sampling protocols depend on careful planning of the actual procedures used in sample collection, handling, and transfer. Protocols are thorough written descriptions of the detailed steps involved in sample collections. Traditional field and laboratory quality control measures are frequently not satisfactory for meaningful results and should be realistically evaluated and refined before incorporating into a protocol. An environmental sampling protocol includes (1) the overall purpose and the specific purpose(s) of the sampling effort; (2) selection of chemical constituents of interest; primary (substances of regulatory concern, such as priority pollutants) and secondary (transformation products, variables needed to meet criteria for representativeness); (3) sampling location and frequency; and (4) sample handling, field determinations, storage and transport. Sampling location/frequency should consider minimal disturbance of samples or local environment and scale problems (bucket vs. surface layer). Sample collection (contact of sample with sampling device) can be a source of error, especially at trace levels. Common error sources are contact with foreign material, loss of volatile substances, and reaction of the sample with the matrix before analysis. Sample handling from collection to analysis should minimize exposure to weather conditions and speed in pretreatment (such as filtration). Blanks and spike samples should be handled in the same manner as the actual samples. (See also W88-09415) (Cassar-PTT)
W88-09416

ASSESSING AND CONTROLLING SAMPLE CONTAMINATION,
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 5A.
W88-09418

STORAGE AND PRESERVATION OF ENVIRONMENTAL SAMPLES,
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 5A.
W88-09419

EVALUATING AND PRESENTING QUALITY ASSURANCE SAMPLING DATA,
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 5A.
W88-09420

SAMPLING WATERS: THE IMPACT OF SAMPLE VARIABILITY ON PLANNING AND CONFIDENCE LEVELS,
Dow Chemical U.S.A., Midland, MI. Mammalian and Environmental Toxicology.
For primary bibliographic entry see Field 5A.
W88-09421

ASSESSMENT OF MEASUREMENT UNCERTAINTY: DESIGNS FOR TWO HETEROSCEDASTIC ERROR COMPONENTS,
National Bureau of Standards (NEL), Gaithersburg, MD.
For primary bibliographic entry see Field 5A.
W88-09422

MODERN SAMPLING EQUIPMENT: DESIGN AND APPLICATION,
Isco, Inc., Lincoln, NE.
For primary bibliographic entry see Field 5A.
W88-09423

SAMPLING GROUNDWATER MONITORING WELLS: SPECIAL QUALITY ASSURANCE AND QUALITY CONTROL CONSIDERATIONS,
IT Corp., Austin, TX.
For primary bibliographic entry see Field 5A.
W88-09425

TECHNIQUES FOR SAMPLING SURFACE AND INDUSTRIAL WATERS: SPECIAL CONSIDERATIONS AND CHOICES,
BCM Converse, Inc., Mobile, AL.
For primary bibliographic entry see Field 5A.
W88-09426

GROUNDWATER SAMPLING,
Satterthwaite Associates, Inc., West Chester, PA.
For primary bibliographic entry see Field 5A.
W88-09427

COPING WITH SAMPLING VARIABILITY IN BIOTA; PERCENTILES AND OTHER STRATEGIES,
Food and Drug Administration, Washington, DC. Center for Food Safety and Applied Nutrition.
For primary bibliographic entry see Field 5A.
W88-09428

COMPOSITE SAMPLING FOR ENVIRONMENTAL MONITORING,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 7A.
W88-09429

CONSIDERATIONS FOR PRESERVING BIOTIC SAMPLES,
New York State Agricultural Experiment Station, Geneva. Analytical Labs.
For primary bibliographic entry see Field 5A.
W88-09430

SAMPLING AND VARIABILITY IN SOILS AND SOLID WASTES,
For primary bibliographic entry see Field 5A.
W88-09431

SAMPLING AND ANALYSIS OF HAZARDOUS AND INDUSTRIAL WASTES: SPECIAL QUALITY ASSURANCE AND QUALITY CONTROL CONSIDERATIONS,
University of Wyoming Research Corp., Laramie. Western Research Inst.
For primary bibliographic entry see Field 5A.
W88-09433

MEASUREMENT OF THE HYDRAULIC CONDUCTIVITY OF FINE-GRAINED SOILS,
Texas Univ. at Austin. Center for Electromechanics.
R. E. Olson, and D. E. Daniel.
IN: Permeability and Groundwater Contaminant Transport. A Symposium Sponsored by the American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes, Philadelphia, Pennsylvania, June 17-23, 1979. ASTM Special Technical Publication 746, 1981. p 18-64, 19 fig, 5 tab, 137 ref.

Descriptors: *Hydraulic conductivity, *Soil water, *Measuring instruments, *Groundwater, *Particle size, Saturated soils, Field tests, Groundwater, Flow velocity, Aeration zone.

Both field and laboratory tests for saturated and partially saturated soils are considered in this review of the state-of-the-art in the measurement of hydraulic conductivity of fine-grained soils. For saturated soils, field tests are to be preferred because they permeate a larger volume of soil, thus taking into account the effects of macrostructure better than laboratory tests. Field tests are generally best performed by using a cylindrical piezometer tip, installed by methods that minimize disturbance, and measuring flow under a constant head. Laboratory specimens should be as large as practical and should be oriented to produce flow in the direction of maximum hydraulic conductivity. The permeant should be a fluid similar to that encountered in the field. Without proper experimental technique, the conductivity measured in the laboratory may differ from the field value by several orders of magnitude. Field tests for unsaturated soils are not well developed and can only be recommended for cases where water will be ponded on the surface of a site. The most versatile laboratory techniques are the instantaneous profile method using tensiometric or psychrometric probes, and the pressure plate outflow method. The best method to use depends on the soil suction expected in the field. (See also W88-09434) (Author's abstract)
W88-09436

METHODS FOR CONCENTRATION AND RECOVERY OF VIRUSES FROM WASTEWATER SLUDGES,
Florida Univ., Gainesville. Dept. of Microbiology and Cell Science.
For primary bibliographic entry see Field 5A.
W88-09469

METHODS OF ENTEROVIRUS RECOVERY FROM DIFFERENT TYPES OF SOILS,
Epidemiology Research Center, Tampa, FL.
For primary bibliographic entry see Field 5A.
W88-09472

MANAGING GROUND WATER IN MAINE: THREE APPROACHES,
Gerber (Robert G.), Freeport, ME.
For primary bibliographic entry see Field 4B.
W88-09481

IN-SITU ANALYSIS OF GASOLINE-CONTAMINATED GROUND WATER,
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W88-09489

CONTRIBUTION OF SELECTED TOXIC CHEMICALS TO GROUND WATER FROM DOMESTIC ON-SITE SEWAGE DISPOSAL SYSTEMS,
Connecticut Univ., Storrs. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W88-09494

DEVELOPING A STANDARDIZED SYSTEM FOR ENVIRONMENTAL ASSESSMENTS,
Shevenell Gallen and Associates, Inc., Portsmouth, NH.
For primary bibliographic entry see Field 7A.
W88-09507

USE OF REMOTE SENSING, GEOPHYSICAL AND SOIL GAS TECHNIQUES TO LOCATE MONITORING WELLS AT HAZARDOUS WASTES SITES IN NEW HAMPSHIRE,
New Hampshire Dept. of Environmental Services, Concord.
For primary bibliographic entry see Field 7A.

W88-09509

INTERPRETATION OF EM DATA THROUGH GEOELECTRIC MODELING WITH APPLICATION TO A LANDFILL IN SOUTHEASTERN NEW HAMPSHIRE,
Normandeau Engineers, Inc., Concord, NH
For primary bibliographic entry see Field 5A.
W88-09510

USE OF PORTABLE PHOTOIONIZATION METERS TO ASSESS THE LATERAL AND VERTICAL DISTRIBUTION OF CONTAMINANTS AT HAZARDOUS WASTE FACILITIES: A CASE STUDY,
Dunn Geoscience Corp., Albany, NY.
For primary bibliographic entry see Field 5A.
W88-09511

HIGH FREQUENCY PERCUSSION-DRIVEN MICRO-WELLS IMPROVE EFFICIENCY OF CONTAMINANT PLUME DEFINITION,
Pine and Swallow Associates, Acton, MA.
For primary bibliographic entry see Field 7A.
W88-09518

SATELLITE INFRARED TECHNIQUE TO ESTIMATE TROPICAL CONVECTIVE AND STRATIFORM RAINFALL,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 2B.
W88-09534

EVAPORATION OF RAIN FALLING FROM CONVECTIVE CLOUDS AS DERIVED FROM RADAR MEASUREMENTS,
Hebrew Univ. of Jerusalem (Israel). Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W88-09535

WATER RESOURCES ASSESSMENT: A SPATIAL EQUILIBRIUM APPROACH,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 7A.
W88-09538

TRACE ELEMENT CONCENTRATIONS IN NEAR-SURFACE WATERS OF THE GREAT LAKES AND METHODS OF COLLECTION, STORAGE, AND ANALYSIS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
R. Rossmann, and J. Barres.
Journal of Great Lakes Research JGLRDE, Vol. 14, No. 2, p 188-204, 1988. 7 fig, 16 tab, 11 ref.

Descriptors: *Water analysis, *Lakes, *Trace elements, *Heavy metals, *Sampling, *Great Lakes, Metals, Lake Erie, Lake Michigan, Lake Superior, Lake Ontario, Lake Huron, Particulate matter, Sample preservation, Water sampling, Water analysis.

From 1980 through 1985, waters of the Great Lakes were sequentially sampled for dissolved, particulate, and total trace elements. Major sampling occurred in 1980 for Lake Huron, in 1981 for Lakes Erie and Michigan, in 1983 for Lake Superior, and in 1985 for Lake Ontario. Great care was taken during collection, storage, and analysis to prevent sample contamination and to document any contamination occurring. Trace elements measured by atomic absorption techniques were silver, aluminum, arsenic, boron, barium, beryllium, bismuth, cadmium, cobalt, chromium, strontium, vanadium, and zinc. All results were field and laboratory blank corrected. Excluding aluminum, barium, iron, and strontium, concentrations of trace elements in most of the Great Lakes were a few ppb or less, with many elements being below 1 ppb. Element concentrations were highest in Lakes Erie and Michigan and lowest in Lakes Huron and Superior. All five Great Lakes had more than 50% of their total iron, aluminum, and manganese associated with particulate matter. (Author's abstract)
W88-09553

INTERCALIBRATION EXERCISE FOR TRACE METALS IN MARINE SEDIMENTS,
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 5A.
W88-09559

SUMMARY OF THE GLOBAL WEATHER EXPERIMENT WORKSHOPS ON THE HYDROLOGICAL CYCLE AND DATA ASSIMILATION,
Utah Univ., Salt Lake City. Dept. of Meteorology.
For primary bibliographic entry see Field 2A.
W88-09561

MICRODETERMINATION OF VANADIUM IN WATER SAMPLES,
Naval Chemical and Metallurgical Lab., Bombay (India).
For primary bibliographic entry see Field 5A.
W88-09565

DEVELOPMENTS IN THE SPECIATION AND DETERMINATION OF ALKYLMETALS (SN, PB) USING VOLATILIZATION TECHNIQUES AND CHROMATOGRAPHY-ATOMIC ABSORPTION SPECTROSCOPY,
New Hampshire Univ., Durham. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W88-09567

SINGLET OXYGEN ANALYSIS IN IRRADIATED SURFACE WATERS,
Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Chimie Physique.
A. M. Braun, F. H. Frimmel, and J. Hoigne.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 27, No. 1+2, p 137-149, October 1986. 10 fig, 1 tab, 24 ref.

Descriptors: *Chemical analysis, *Humic acids, *Oxygen, *Surface water, *Ions, Oxidation-reduction reactions, Water analysis, Chemical reactions.

There has been a growing interest in quantitative analysis of photochemically produced oxidants in natural surface waters because of their importance in the redox reactions of organic and inorganic compounds. In this paper, quantitative singlet oxygen analysis is described as well as the application of this method for the determination of quantum yields of photooxidation and singlet oxygen production. The importance of photosensitized production of singlet oxygen by humic materials is evaluated. (Miller-PTT)
W88-09569

RECENT METHODOLOGICAL PROGRESS IN CADMIUM ANALYSIS,
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Angewandte Physikalische Chemie.
For primary bibliographic entry see Field 5A.
W88-09571

FOREST DAMAGE: CHARACTERIZATION OF SPRUCE NEEDLES BY PYROLYSIS FIELD IONIZATION MASS SPECTROMETRY,
Fachhochschule Fresenius, Wiesbaden (Germany, F.R.). Dept. of Trace Analysis.
For primary bibliographic entry see Field 5C.
W88-09572

DETERMINATION OF 'HEAVY' ORGANOTIN POLLUTION OF WATER AND SHELLFISH BY A MODIFIED HYDRIDE ATOMIC ABSORPTION PROCEDURE,
Universite de Pau et des Pays de l'Adour (France). Lab. de Chimie Analytique.
For primary bibliographic entry see Field 5A.
W88-09573

ANALYSIS OF POLYCYCLIC AROMATIC HYDROCARBONS IN LACUSTRAL SEDIMENTS BY HIGH RESOLUTION SHPOL'SKII SPECTROFLUORIMETRY AT 10 K,
Universite de Savoie, Chambery (France). Lab. de Spectroscopie Moleculaire.
For primary bibliographic entry see Field 5A.
W88-09579

DETERMINATION OF TRIALKYLLEAD SPECIES IN WATER SAMPLES,
Dortmund Univ. (Germany, F.R.). Inst. of Occupational Health.
For primary bibliographic entry see Field 5A.
W88-09580

IMPROVEMENT OF THE KJELDAHL METHOD FOR TOTAL NITROGEN INCLUDING ACID-HYDROLYZABLE PHOSPHORUS DETERMINATIONS IN FRESHWATER ECOSYSTEMS,
Chile Univ., Santiago. Dept. de Ciencias Ecologicas.
H. A. Muhlhauser, L. Soto, and P. Zahradnik.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 3, p 215-226, February 1986. 3 fig, 2 tab, 14 ref.

Descriptors: *Kjeldahl procedure, *Nitrogen, *Phosphorus, *Ecosystems, *Colorimetry, Chile, Sediments, Nutrients, Macrophytes, Nitrates, Nitrites, Phosphates.

A simpler, faster and accurate alternative procedure for the traditional Kjeldahl method is reported. Besides total nitrogen determination, it also allows the determination of acid-hydrolyzable phosphorus. The procedure does not distinguish N-NO2 and N-NO3. The method is sensitive at the microgram level in samples containing 10 to 200 micrograms N/Litre and 10 to 200 micrograms P/l. Nitrogen and phosphorus are determined colorimetrically. Reproducibility is better than + or - 10%. P-PO4 and N-NH3 in water, sediments, aquatic macrophytes and terrestrial plants collected in central Chile have been determined using the method reported here. (Author's abstract)
W88-09581

STABILITY OF PRECIPITATION SAMPLES UNDER FIELD CONDITIONS,
Netherlands Energy Research Foundation ECN, Petten.
J. Slanina, J. H. Baard, B. C. Broersen, J. J. Mols, and P. I. Voors.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 28, No. 4, p 247-261, February 1987. 5 fig, 5 tab, 10 ref.

Descriptors: *Sample preservation, *Sampling, *Contamination, *Water analysis, *Precipitation, *Water sampling, Field tests, Regression analysis, Tree elements, Statistics, Errors.

Eight wet-only samplers placed in one location were used to sample precipitation. Subsamples were taken from the sample bottles directly after the precipitation event and at regular intervals up to a period of 2100 hours and analyzed for bulk and trace elements, while the samples stayed in the samplers under field conditions. Outliers were deleted by means of conventional statistical techniques. The resulting data base was tested by means of the F-test for consistency and for changes in the chemical composition of precipitation samples directly after sampling or after an extended stay under field conditions. Eighty-one percent of the samples showed consistent results and no clear indication of chemical changes was found. Regression analysis indicated that the uncertainties for samples analyzed after one week are less than 5% generally for the bulk elements and less than 14% for the trace elements. After a period of 400 hours, the uncertainties for the bulk elements increase to a level of 5-10% and 5-30% for the trace elements. Contamination as a result of handling the samples

to obtain subsamples seems the main cause for the increase of the concentrations which were observed. Contamination during the sample pretreatment and analysis in the laboratory is probably of minor importance. (Author's abstract)
W88-09582

GC/MS, HPLC AND FAB MASS SPECTROPHOTOMETRIC ANALYSIS OF ORGANIC MICROPOLLUTANTS IN BARCELONA'S WATER SUPPLY,
Instituto de Quimica Bio-Organica, Barcelona (Spain). Lab. d'Espectrometria de Masses.
For primary bibliographic entry see Field 5A.
W88-09583

PCB TRACE ENRICHMENT FROM CONTAMINATED NATURAL WATER AT THE SUB PPT LEVEL ON C18 MICRO CARTRIDGES,
Liege Univ. (Belgium). Zoology Inst.
For primary bibliographic entry see Field 5A.
W88-09585

EFFECT OF FILTRATION AND CENTRIFUGATION ON THE DETERMINATION OF ALUMINUM IN WATER,
Norsk Inst. for Skogforskning, Aas.
O. Royset, A. O. Stuanes, G. Ogner, and G. Sjotveit.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 29, No. 1+2, p 141-149, March 1987. 3 fig, 2 tab, 16 ref.

Descriptors: *Water analysis, *Laboratory methods, *Aluminum, Surface water, *Leachates, Water sampling, Pollutant identification, Particulate matter, Spectrophotometry, Colloids, Filtration, Centrifugation, Surface water, Membrane filters, Surface water.

The effect of filtration and centrifugation on the determination of aluminum in surface and leachate water was studied. For surface and leachate water samples, only small effects were observed after filtration through 0.45 micrometer or 0.22 micrometer pore size membrane filters compared to unfiltered samples. For over 80% of the samples which contained 0.01-15 mgAl/L, the differences between unfiltered and filtered samples were less than 0.10 mgAl/L; only for about 5% of the samples were the differences above 0.20 mgAl/L observed. (Author's abstract)
W88-09586

ANALYTICAL CHEMISTRY OF CHROMIUM SPECIES IN THE ENVIRONMENT, AND INTERPRETATION OF RESULTS,
Bayer A.G., Leverkusen (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W88-09589

DETERMINATION OF METHYL- AND ETHYLMERCURY IN NATURAL WATERS AT SUB-NANOGRAM PER LITER USING SCF-ADSORBENT PRECONCENTRATION PROCEDURE,
Swedish Environmental Research Inst., Goeteborg.
For primary bibliographic entry see Field 5A.
W88-09590

MULTICOLUMN ION CHROMATOGRAPHIC DETERMINATION OF NITRATE AND SULFATE IN WATERS CONTAINING HUMIC SUBSTANCES,
Lund Univ. (Sweden). Dept. of Analytical Chemistry.
E. Hoffmann, G. Marko-Varga, I. Csiky, and J. A. Jonsoon.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 25, No. 1-3, p 161-171, June 1986. 5 fig, 1 tab, 16 ref.

Descriptors: *Chemical analysis, *Laboratory equipment, *Humic substances, *Chromatography, *Nitrates, *Sulfates, Water sampling, Ion exchange.

A three-column ion chromatographic system for the removal of humic substances from natural waters and subsequent on-line concentration and determination of nitrate and sulfate using non-suppressed ion chromatography is presented. Humic substances are removed using disposable adsorption columns packed with chemically bonded amine silica material. The sample is directly transferred to an ion exchange column where the anions are concentrated ca 10 times. After reversing the flow, the ions are transferred to a third column where they are separated and quantified. The detection limit is less than 1 mg/L of nitrate or sulfate in water containing 45 mg/l of humic acid. (Author's abstract)
W88-09608

2-(5-BROMO-2-PYRIDYLAZO)-5-DIMETHYLAMINOPHENOL (5-BR-DMPAP) AS A REAGENT FOR SPECTROPHOTOMETRIC DETERMINATION OF IRON(III),
Environmental Science Research Inst. of Guanzhou Prefecture, Ganzhou (China).
X. Qui, and Y. Zhu.
International Journal of Environmental Analytical Chemistry IJEAA3, Vol. 26, No. 1, p 19-25, July 1986. 3 fig, 1 tab, 7 ref.

Descriptors: *Chemical analysis, *Water analysis, *Spectrophotometry, *Iron, *Irrigation water, 5-Br-DMPAP.

A new color reaction of iron(III) with 2-(5-Bromo-2-Pyridylazo)-5-Dimethylaminophenol (5-Br-DMPAP) has been studied systematically. In dilute acetic acid solution (0.06-0.8 N), iron(II) can form a colored complex with 5-Br-DMPAP. The complex exhibits maximum absorption at 600 nm, and the value of the apparent molar absorption coefficient is found to be 74,000. The composition of the complex is also established as Fe(III):5-Br-DMPAP = 1:2 by the methods of continuous variation and mole ratio as well as slope ratio. The Lambert-Beer law is obeyed in the range of 0 to 8 micrograms iron/ml. The proposed new method is reasonably selective and sensitive for iron(III) and was satisfactorily applied to the determination of iron(III) in irrigation water. (Author's abstract)
W88-09612

DETERMINATION OF THE SPECIATION OF CHROMIUM FROM A BICYCLE FACTORY DISCHARGE,
Dar es Salaam Univ. (Tanzania). Kunduchi Marine Biological Station.
For primary bibliographic entry see Field 5B.
W88-09615

DILUTION BIOASSAYS: THEIR APPLICATION TO ASSESSMENTS OF NUTRIENT LIMITATION IN HYPEREUTROPHIC WATERS,
North Carolina Univ., Morehead City. Inst. of Marine Sciences.
H. W. Paerl, and N. D. Bowles.
Hydrobiologia HYDRB8, Vol. 146, No. 3, p 265-273, March 30, 1987. 7 fig, 2 tab, 18 ref. NSF BSR 8314702, University of North Carolina Water Resources Research Institute Project A-122 NC, and North Carolina Sea Grant Projects R/MER-1 and R/MER-2.

Descriptors: *Eutrophication, *Bioassay, *Water analysis, *Nutrients, *Limiting nutrients, Phytoplankton, Nuisance algae, Impaired water quality, Water quality standards, Nitrogen, Phosphorus, Iron, Trace metals, Neuse River, North Carolina, Water quality management.

Hypereutrophic waters, which are characterized by nutrient inputs exceeding phytoplankton nutrient requirements, are often sites of chronic nuisance algal blooms and associated water-quality deterioration problems. In order to restore such systems to acceptable water-quality standards, identification of growth-limiting nutrients is of central importance. Conventional nutrient-addition bioassay techniques are often ineffective in identifying potentially limiting nutrients, due to persistent nutrient excesses in hypereutrophic systems. Accordingly, we have developed a nutrient-dilution bioassay, in which stepwise dilutions of phytoplankton nutrients (nitrogen, phosphorus, iron, trace metals) with a nutrient-free major-ion solution are capable of: 1) identifying those nutrients potentially most limiting, and 2) establishing magnitudes of respective nutrient-input cutbacks required to bring about nutrient-limited control of phytoplankton growth. In situ deployment of dilution bioassays should help establish criteria governing minimal nutrient inputs required to arrest undesirable impacts of hypereutrophy. We have evaluated the field applicability of dilution bioassays during a 2-year trial in the periodically hypereutrophic Neuse River, North Carolina. (Author's abstract)
W88-09634

WATER QUALITY STUDIES ON BUCKINGHAM CANAL (MADRAS, INDIA): A DISCRIMINANT ANALYSIS,
Presidency Coll., Madras (India). Dept. of Zoology.
For primary bibliographic entry see Field 5A.
W88-09641

STUDY OF METAL SORPTION/DESORPTION PROCESSES ON COMPETING SEDIMENT COMPONENTS WITH A MULTICHAMBER DEVICE,
Technische Univ. Hamburg-Harburg (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W88-09705

VENTURI FLUME OF MINIMUM SPACE REQUIREMENTS,
Ecole Polytechnique Federale de Lausanne (Switzerland). Chaire de Constructions Hydraulics.
W. H. Hager.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 226-243, May 1988. 11 fig, 1 tab, 14 ref, 3 append.

Descriptors: *Weirs, *Flow profiles, *Stage-discharge relations, *Venturi flume, *Hydraulics, *Mathematical analysis, *Discharge measurement.

The flow features of a Venturi flume, constricted with sharp-edged, thin-plated elements were investigated. These elements, located at both side walls of a rectangular duct, as are usually found in large municipal sewers, are fixed at the bottom and at the ceiling by a simple device. Particular attention is paid to the head-discharge equation for various constriction rates, the limit submergence, and the discussion of the internal flow mechanism. The theoretical approach accounts for the effects of fluid separation from the constriction elements and for the streamline curvature. Compared to the conventional discharge equation, the effects of the contraction geometry and the relative energy head are included. The final result corresponds to an explicit equation for discharge once the contraction geometry is fixed and the upstream flow depth is recorded. Design curves allow a rapid and precise determination of discharge. (Author's abstract)
W88-09734

FURROW FLOW MEASUREMENT ACCURACY,
Agricultural Research Service, Kimberly, ID.
For primary bibliographic entry see Field 7C.
W88-09735

CHARACTERIZATION OF LIGHT REGIME CHANGES (PAR) BY IRRADIANCE REFLECTANCE IN TWO AMAZONIAN WATER BODIES WITH DIFFERENT PHYSICO-CHEMICAL PROPERTIES,
Kiel Univ. (Germany, F.R.). Botanisches Inst.
For primary bibliographic entry see Field 2H.
W88-09761

COLLECTION MANIFOLD FOR MULTILEVEL GROUND-WATER SAMPLING DEVICES,
British Geological Survey, Keyworth (England).

Fluid Processes Research Group.
S. P. Hitchman.
Ground Water GRWAAR, Vol. 26, No. 3, p 348-349, May-June 1988. 2 fig, 3 ref.

Descriptors: *Groundwater, *Sampling, *Water sampling, Groundwater pollution, Field tests, Radioactive tracers.

A sampling manifold was developed that allows the rapid collection of ground water from multilevel samplers during tracer tests. The manifold is cheap and easily assembled. The graduated syringe allows reasonably accurate, repeatable volumes to be collected. Compared with the sampling method used in previous tracer experiments, that of connecting a vacuum line to each sampling point in turn, the manifold has a number of advantages. Sampling takes about 1/5 of the time, even less if there is more than one operator, preventing a backlog when samples are to be analyzed on site and allowing 'breathing space' when the sampling interval is short. It is safer when using active tracers, as there is less chance of splashing and contamination. Because all sampling points are under vacuum at the same time, ground water is less likely to be drawn from adjacent sampling areas. (Sand-PTT)
W88-09788

MEASUREMENT OF BACTERIAL GROWTH RATES IN SUBSURFACE SEDIMENTS USING THE INCORPORATION OF TRITIATED THYMIDINE INTO DNA,
Dayton Univ., OH. Dept. of Biology.
P. M. Thorn, and R. M. Ventullo.
Microbial Ecology MCBEBU, Vol. 16, No. 1, p 3-16, 1988. 3 fig, 5 tab, 41 ref.

Descriptors: *Soil bacteria, *Subsurface sediments, *Bacteria, *Ecosystem, Growth, DNA, Tritium, Soil types, Clays, Sand, Silt, Radioactive tracers, Oklahoma, Wisconsin, Michigan.

Microbial growth rates in subsurface sediment from three sites were measured using incorporation of tritiated thymidine into DNA. Sampling sites included Lula, Oklahoma, Traverse City, Michigan, and Summit Lake Wisconsin. The method required (1) thymidine concentrations >125 nM, (2) incubation periods <4 h, (3) addition of sodium dodecyl sulfate (SDS) and EDTA for optimum macromolecular extraction, and (4) DNA purification, in order to accurately measure the rate of thymidine incorporation. Macromolecule extraction recoveries, as well as percentage of tritium label incorporated into the DNA fraction, were variable and largely depended upon sediment composition. In general, sandy sediments yielded higher extraction recoveries and demonstrated a larger percentage of label incorporated into DNA than sediments that contained a high silt-clay component. Reported results also indicate that the acid-base hydrolysis procedure routinely used for macromolecular fractionation in water samples may not be routinely applicable to the modified sediment procedure where addition of SDS and EDTA are required for macromolecular extraction. Growing rates exhibited by subsurface communities are relatively slow, ranging from 510,000 to 1020,000 cells/g/day. These rates are 2 to 1,000-fold lower than growth rates measured in surface sediments. These data lend support to the supposition that subsurface microbial communities are nutritionally stressed. (Author's abstract)
W88-09790

MICROBIAL COMMUNITIES IN THE SATURATED GROUNDWATER ENVIRONMENT: I. METHODS OF ISOLATION AND CHARACTERIZATION OF HETEROTROPHIC BACTERIA,
Bremen Univ. (Germany, F.R.).
J. Kolbel-Boelke, B. Tienken, and A. Nehrkorn.
Microbial Ecology MCBEBU, Vol. 16, No. 1, p 17-29, 1988. 3 tab, 50 ref.

Descriptors: *Bacterial analysis, *Soil bacteria, *Bacteria, *Heterotrophic bacteria, *Groundwater, Taxonomy, Cluster analysis.

A method is described for isolation and morphological and physiological characterization of groundwater bacteria based on numerical taxonomy and cluster analysis. and using a miniaturized test system (microtiter plates). Bacteria were isolated randomly on P-agar, and each strain was characterized in regard to 155 features. The media for biochemical differentiation are listed as well as methods of morphological discrimination. Strains of heterotrophic and oligotrophic bacteria (246), isolated from 5 water samples from different depths of the saturated groundwater area, were used for optimizing media and test reactions. (See also W88-09792) (Author's abstract)
W88-09791

EQUIVALENCE OF MICROBIAL BIOMASS MEASURES BASED ON MEMBRANE LIPIDS AND CELL WALL COMPONENTS, ADENOSINE TRIPHOSPHATE, AND DIRECT COUNTS IN SUBSURFACE AQUIFER SEDIMENTS,
Florida State Univ., Tallahassee. Dept. of Biological Science.
D. L. Balkwill, F. R. Leach, J. T. Wilson, J. F. McNabb, and D. C. White.
Microbial Ecology MCBEBU, Vol. 16, No. 1, p 73-84, 1988.

Descriptors: *Aquifers, *Subsurface sediments, *Bacteria, *Bacterial analysis, *Soil bacteria, Biomass, Adenosine triphosphate, Biological membranes, Microscopy, Lipids.

An uncontaminated subsurface aquifer sediment contains a sparse microbial community consisting primarily of coccobacillary bacteria of relatively uniform size which can be counted directly with appropriate staining. The morphological simplicity and the relatively decreased cell numbers, when compared with surface soils and sediments, make the subsurface an ideal natural community with which to compare the utility of chemical measures of microbial biomass to direct microscopic counts. The membrane phospholipids (estimated as the polar lipid fatty acids, the lipid phosphate, and the phospholipid glycerol phosphate), lipopolysaccharide (LPS) lipid A (estimated as the LPS hydroxy fatty acids), cell walls (estimated as the muramic acid), and ATP all give essentially identical estimates of cell numbers and dry weight as the direct counts, using conversion factors determined on subsurface microorganism monocultures. Assays of microbial cell components are thus validated by comparison with the classical direct count in at least one soil/sediment. (Author's abstract)
W88-09795

SOME SPECIAL PROBLEMS IN THE DETERMINATION OF VIABLE COUNTS OF GROUNDWATER MICROORGANISMS,
Kiel Univ. (Germany, F.R.). Inst. fuer Allgemeine Mikrobiologie.
P. Hirsch, and E. Rades-Rohkohl.
Microbial Ecology MCBEBU, Vol. 16, No. 1, p 99-113, 1988. 2 fig, 8 tab, 16 ref.

Descriptors: *Groundwater, *Sediments, *Microorganisms, *Bacteria, *Soil bacteria, *Bacterial analysis, Aquifer characteristics, Wells, Seasonal variation, Water depth, Aquifer characteristics, Laboratory methods, Segeberg Forest, Germany.

Factors affecting viable cell counts in groundwater or sediments were studied with samples from the Segeberg Forest test area in northern Germany. There was very little variation in results with the season or depth of sampling; generally there were 1000-10,000 aerobic cells/ml or g sediment. Long incubation times resulted in higher cell counts; groundwater samples required 4-5 weeks, and sediment extracts had to be cultured for 7 weeks. Total cell counts in sediment were 1000-10,000 cells/g higher than viable cell counts of aerobes. This was explained partly by the additional presence of anaerobes and partly by the observation that some morphotypes may not have grown under the present conditions. Viable cell counts were not influenced by cell extraction from the sediment with either sodium pyrophosphate or groundwater extracts. However, iron-precipitating or manganese-oxidizing bacteria were better extracted with sterile groundwater. The microflora of wells was more numerous than that of the free aquifer; consequently it was better to pump off all well water before aquifer water was sampled. The diameter of the well was also important; thinner tubes had higher cell counts than those with wider diameter. For sampling, wells should be at least 1 year old, since young wells contain higher numbers of microorganisms due to underground disturbances from the drilling. Turbid water samples could be clarified by filtration, but this reduced the viable counts by 1-2 orders of magnitude. Two different media inoculated with a sample dilution resulted in the same cell counts, but their microbial diversity was different. Storage of groundwater samples before processing resulted in up to 17-fold increase in cell counts and loss of diversity in the first 24 hours. Cell numbers decreased slowly during longer storage. (Author's abstract)
W88-09797

ASSESSING BIOTIC INTEGRITY OF THE FISH COMMUNITY IN A SMALL ILLINOIS STREAM,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
P. L. Angermeier, and I. J. Schlosser.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 3, p 331-338, Summer 1987. 4 fig, 4 tab, 28 ref. Water Resources Center, University of Illinois grant A-093-LLL, Illinois Institute of Natural Resources grant 20.113, Environmental Protection Agency grant R.806391.

Descriptors: *Stream fisheries, *Bioindicators, *Water pollution effects, *Fish populations, Water quality, Aquatic habitats, Illinois.

Integrity of the fish community in a small Illinois stream was assessed from 1978 to 1980 with two indices, the index of biotic integrity (IBI) and the Shannon-Wiener diversity index (H'). The IBI identified known degradation in water quality and habitat structure more reliably than did H'. Assessments of site quality with IBI were consistent over the three sample years but varied according to H'. Omission of young-of-year fishes reduced scores for both indices, but did not affect assessment performance for IBI as much as for H'. The breadth of information incorporated into IBI (e.g. species composition, trophic habits) seems to make it more generally useful in detecting degradation than H'. (Author's abstract)
W88-09818

TRITIUM HYDROLOGIC STUDIES IN FOUR CLOSED-BASIN LAKES IN THE GREAT BASIN, U.S.A.,
Lamont-Doherty Geological Observatory, Palisades, NY.
A. L. Herczeg, and D. M. Imboden.
Limnology and Oceanography LIOCAH, Vol. 33, No. 2, p 157-173, March 1988. 14 fig, 5 tab, 26 ref.

Descriptors: *Tracers, *Lakes, *Radioisotopes, *Tritium, *Closed lakes, *Lake evaporation, Hydrology, Great Basin, Water sampling, Fallout, Temporal distribution, Hydrologic models, Evaporation rate, Relative humidity, Spatial distribution, Rain, Enrichment, Depletion.

Four closed-basin lakes in the Great Basin (Lake Abert, Oregon; Mono Lake, California; Pyramid and Walker Lakes, Nevada) were analyzed for the tritium isotope of hydrogen in water samples collected in 1969, 1976, 1980, and 1981. In each case the tritium concentration increased to a maximum in the mid-to-late 1960s in response to fallout produced by nuclear-weapons testing and then slowly decreased soon after the 1966 moratorium. The highest level attained was a function of the water-residence time of the lake (i.e., shorter residence time corresponding to higher maximum tritium concentration), and the rate of decrease was slowest for lakes with longer water-residence times. The residence time of tritium is less than the water-residence time and depends strongly on the evaporative exchange of tritium with the atmosphere. A

tritium hydrologic model was constructed in an attempt to constrain hydrologic properties such as evaporation rate, relative humidity, and the degree of homogeneity of the water column with respect to tritium. If evaporation rates determined from hydrologic balance are within 20% of the true rates, then the tritium input must be between 50 and 90%-enriched over that calculated from data on tritium fallout in Portland rain. This enrichment is considerably reduced if the surface waters are on the average depleted by about 10% in tritium relative to the whole lake. Calculated mean relative humidities lie between 0.45 (Mono Lake) and 0.25 (Walker Lake). Calculated exchange velocities in the gas phase are between 17 and 27 m/h, which corresponds to a mean wind speed of about 4 m/s. (Author's abstract)
W88-09843

DISCOVERIES AND TESTABLE HYPOTHESES ARISING FROM COASTAL ZONE COLOR SCANNER IMAGERY OF SOUTHERN LAKE MICHIGAN,
Wisconsin Univ., Milwaukee. Center for Great Lakes Studies.
For primary bibliographic entry see Field 2H.
W88-09846

LABORATORY STUDIES ON CORE SAMPLING WITH APPLICATION TO SUBTIDAL MEIOBENTHOS COLLECTION,
Louisiana State Univ., Baton Rouge. Dept. of Zoology and Physiology.
P. A. Rutledge, and J. W. Fleeger.
Limnology and Oceanography LIOCAH, Vol. 33, No. 2, p 274-280, March 1988. 1 fig, 1 tab, 28 ref.

Descriptors: *Core sampling, *Bottom sampling, *Sample preservation, *Coastal waters, *Benthos, Simulation, Sediments, Cores, Flocculation, Freezing.

Three aspects of subtidal meiobenthic sampling were examined through laboratory simulation experiments with Sephadex gel beads as an epibenthic meiofaunal mimic. Results indicate that corer diameter (i. d. from 2.6 to 10.5 cm) does not effect sampling efficiency if slow corer penetration takes place. Disturbance in cores mimicking conditions during retrieval by a diver resulted in a bias when these cores were subsampled after collection. Such effects may also be present in larger (e.g., box) corers when a distinct flocculent layer is present. A dramatic effect on vertical profile was found when cores were preserved by fast-freezing. Cores should be of a size that can be analyzed in their entirety, subsampled as a homogenate, or subsampled with a device in place as the corer enters the sediment. (Author's abstract)
W88-09847

MOTILE EPIFAUNA OF MARINE MACROPHYTES IN THE INDIAN RIVER LAGOON, FLORIDA: I. COMPARISONS AMONG THREE SPECIES OF SEAGRASSES FROM ADJACENT BEDS,
Harbor Branch Foundation, Inc., Fort Pierce, FL.
For primary bibliographic entry see Field 2L.
W88-09857

LARGE-SCALE CLOUD DISTRIBUTIONS AND THEIR SEASONAL VARIATIONS AS DERIVED FROM GMS-IR OBSERVATIONS,
Tokyo Univ. (Japan). Ocean Research Inst.
For primary bibliographic entry see Field 2B.
W88-09866

ESTIMATES OF THUNDERSTORM PRECIPITATION EFFICIENCY FROM FIELD MEASUREMENTS IN CCOPE,
National Center for Atmospheric Research, Boulder, CO.
For primary bibliographic entry see Field 2B.
W88-09872

DETERMINATION OF DISSOLVED CO2 IN UPLAND STREAMWATER,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5A.
W88-09920

SINGLE-WELL TRACER TECHNIQUE FOR EVALUATING AQUIFER PARAMETERS: I. THEORETICAL WORK,
Hydrology Service, Jerusalem (Israel).
Y. Bachmat, S. Mandel, and M. Bugayevski.
Journal of Hydrology JHYDA7, Vol. 99, No. 1/2, p 143-163, May 1988. 6 fig, 8 ref, 4 append.

Descriptors: *Aquifer characteristics, *Tracers, *Test wells, *Pumping tests, *Aquifer testing, *Groundwater movement, Dispersivity, Porosity, Field tests, Analytical methods, Solute transport, Data interpretation, Model studies, Mathematical studies, Equations, Data collections, Hydrologic data.

The theoretical basis of a field technique for evaluating longitudinal dispersivity and effective porosity by a single-well test is presented. A measured quantity of an ideal tracer is released instantaneously into the well at rest and moves with the natural flow velocity. After a certain delay time the well is pumped at a constant rate and tracer concentrations in the pumped water are monitored. These serve as data for estimating the above parameters. The interpretation of the data is based on an approximate analytical solution of the direct problem by means of the method of small perturbations and superposition and on an iterative procedure for solving the inverse problem. Experimental procedures and field applications of the method will be presented in a forthcoming paper. (Author's abstract)
W88-09921

NORMALLY DISTRIBUTED SAPROBIC INDEX DATA FROM THE BLAGOEVGRADSKA BISTRITZA RIVER,
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
For primary bibliographic entry see Field 5A.
W88-09972

SELECTED DRILL-STEM TEST DATA FOR THE UPPER COLORADO RIVER BASIN,
Geological Survey, Lakewood, CO. Water Resources Div.
R. W. Teller, and D. T. Chafin.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Water-Resources Investigations Report 84-4146, 1986. 112 p, 15 fig, 11 tab, 57 ref.

Descriptors: *Hydrologic data, *Drill-stem tests, *Permeability, *Hydraulic conductivity, *Fluid temperature, *Stratigraphic columns, *Sampling, Hydrogeologic units, Upper Colorado River Basin, Geohydrology.

Permeability data from aquifers and confining layers may be available from drill-stem tests made during the course of petroleum exploration. During the drill-stem test, the stratigraphic interval of interest is isolated in the hole by the use of packers attached to the drill string. Fluid flows into the drilling pipe under the influence of the formation head. Pressure measurements and other data collected during the course of the test are used to gain information on undisturbed formation head, permeability, hydraulic conductivity, and fluid temperature. Drill-stem test data for individual formation in the Upper Colorado River Basin presented in tables in this report are arranged in groups of 10 hydrogeologic units that were classified on the basis of geologic age, location, depositional environment and lithology. Maps indicating the locations of test sites and areal distribution of test data within the 10 units are provided at the beginning of each table. Stratigraphic columns also are provided to identify the relative ages of the formation tested and to correlate regional hydrogeologic units. (USGS)
W88-10068

TRACE ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN WATER BY GC AND HPLC,
Iowa State Univ., Ames. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W88-10077

7C. Evaluation, Processing and Publication

FALSE WHAT: FALSE POSITIVE RATES IN GROUNDWATER MONITORING,
For primary bibliographic entry see Field 7B.
W88-09003

PACIFIC NORTHWEST RIVERS STUDY ASSESSMENT GUIDELINES: WASHINGTON STATE.
Washington State Energy Office, Olympia.
For primary bibliographic entry see Field 6G.
W88-09032

STATUS OF THE NATION'S WATER QUALITY INFORMATION ACTIVITIES.
Geological Survey, Reston, VA. Office of Water Data Coordination.
Proceedings of the Joint Meeting Advisory Committee on Water Data for Public Use, Interagency Advisory Committee on Water Data, Department of the Interior. Meeting held May 19-21, 1987, Charlottesville, VA. 1987. 114 p, 9 fig, 14 tab.

Descriptors: *Water data, *Interagency coordination, *Data collections, *Information exchange, *Conferences, Water quality, Water quality management, Water supply, Water quality control, Water pollution prevention, Water pollution control, Monitoring, Water management, Groundwater management, Hydrologic data collections, Data bases, Geological Survey, Policy making.

The status of the Nation's water-quality information activities was discussed at a joint meeting of the Department of the Interior Advisory Committees on Water Data, May 19-21, 1987, in Charlottesville, Virginia. Participants at the meeting included members of the Department's Advisory Committee on Water Data for Public Use and its Federal counterpart, the Interagency Advisory Committee on Water Data. In addition to the keynote address on water management for quality and quantity and its relation to data gathering and data management, reports from several federal agencies (Army Corps of Engineers, National Oceanic and Atmospheric Administration, Fish and Wildlife Service, Soil Conservation Service, Environmental Protection Agency, and Geological Survey) and representatives of New Jersey, California, and Nebraska were given. These reports describe water quality programs and the unique challenges they face such as the need to integrate water resource management, and surface and groundwater quality and quantity management in a complex legal and institutional environment. A panel discussion was also held that addressed nationwide water quality data collection and analysis activities. The Geological Survey through the Office of Water Data Coordination will actively pursue the concerns identified by this advisory forum and will assure that the recommendations formulated in this meeting are given full consideration during the development of Survey programs. The non-Federal advisory committee will continue to be involved with the Federal sector policymakers on issues where water data are critical. (See W88-09040 thru W88-09044) (Geiger-PTT)
W88-09039

WATER MANAGEMENT FOR QUALITY AND QUANTITY: ITS RELATION TO DATA GATHERING AND DATA MANAGEMENT,
J. van Schilfgaarde.
IN: Status of the Nation's Water Quality Information Activities. Proceedings of a meeting held May 19-21, 1987, Charlottesville, VA. 1987. p 4-11, 7 ref.

Descriptors: *Monitoring, *Hydrologic data collections, *Water quality, *Water management, Water pollution prevention, Data interpretation,

Data acquisition, Water quality control, Management planning, Water pollution control, Computer models.

Water quality monitoring programs are routinely justified by the need for baseline data, for determining trends, and to assess the effect of actions or changes in circumstances. In developing a water quality monitoring network, specific guidelines should be followed. Monitoring should lend itself to clear definition of goals in advance, or establishment of techniques for data analysis. Long-term continuity in data gathering must be assured. Quality control should be adequate. Appropriate sampling procedures should be emphasized, especially for groundwater. Other natural resources should be properly managed to protect water quality. Computer models should be used to enhance water quality monitoring programs and not to take the place of a well managed monitoring network. (See also W88-09039) (Geiger-PTT)
W88-09040

ROLE OF THE FISH AND WILDLIFE SERVICE IN WATER-QUALITY MONITORING,
For primary bibliographic entry see Field 7B.
W88-09042

WATER QUALITY INFORMATION ACTIVITIES OF THE SOIL CONSERVATION SERVICE,
For primary bibliographic entry see Field 7A.
W88-09043

WATER QUALITY INFORMATION ACTIVITIES OF THE GEOLOGICAL SURVEY,
For primary bibliographic entry see Field 7A.
W88-09044

SOURCES OF PHOSPHATE WHICH GIVE RISE TO EUTROPHICATION IN SOUTH AFRICAN WATERS,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5B.
W88-09047

DETERMINING UNCERTAINTY IN PHYSICAL PARAMETER MEASUREMENTS BY MONTE CARLO SIMULATION,
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 5B.
W88-09092

DRASTIC: A SYSTEM TO EVALUATE THE POLLUTION POTENTIAL OF HYDROGEOLOGIC SETTINGS BY PESTICIDES,
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 5B.
W88-09097

PRINCIPLES OF MODELING PESTICIDE MOVEMENT IN THE UNSATURATED ZONE,
Cornell Univ., Ithaca, NY. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W88-09106

METHOD FOR THE ASSESSMENT OF GROUND WATER CONTAMINATION POTENTIAL: USING A PESTICIDE ROOT ZONE MODEL (PRZM) FOR THE UNSATURATED ZONE,
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W88-09107

ENVIRONMENTAL SAMPLING FOR HAZARDOUS WASTES.
For primary bibliographic entry see Field 7B.
W88-09120

NEW WAYS OF ASSESSING SPATIAL DISTRIBUTIONS OF POLLUTANTS,
Stanford Univ., CA. Aerosol Lab.
For primary bibliographic entry see Field 7A.
W88-09127

DETECTING ELEVATED CONTAMINATION BY COMPARISONS WITH BACKGROUND,
National Bureau of Standards, Washington, DC.
For primary bibliographic entry see Field 7A.
W88-09128

USE OF ANALYTICAL MODELS FOR EVALUATING CORRECTIVE ACTIONS AT HAZARDOUS WASTE SITES,
GeoTrans, Inc., Reston, VA.
R. M. Cohen, and W. J. Miller.
IN: Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring. National Water Well Association, Worthington, OH. 1983. p 85-97, 7 fig, 2 tab, 43 ref.

Descriptors: *Water pollution treatment, *Drains, *Mathematical models, *Water pollution control, *Cutoff walls, *Caps, *Hydrologic models, *Remedies, *Hazardous materials, Drainage, Evaluations, Agricultural engineering, *Model studies.

The application of one-dimensional analytical models to the evaluation of corrective actions at hazardous waste sites was focused on steady state and transient solutions capable of simulating line drains, cutoff walls and caps of low permeability. A discussion on Dupuit-Forchheimer theory and practical considerations in model application is synthesized from literature dealing with agricultural drainage engineering. Analytical solutions are provided for such steady state flow applications as Kirkham's model, Hooghoudt's equation, and Youngs's drain spacing model, and for such transient applications as Maasland's model, Terzidis's equations and Venetis's equation. The numerous steady and transient analytical solutions provide useful quantitative tools for evaluating the conceptual design of alternative corrective actions. However, meaningful application of these models depends on the user's awareness of their governing assumptions and limitations. The degree of compatibility between a chosen model and the actual field situation must be appreciated to avoid model misuse or misinterpretations. (See also W88-09129) (Friedmann-PTT)
W88-09140

PRESENT-DAY MODELING OF SOURCE AND DIRECTION OF GROUND WATER MOVEMENT,
For primary bibliographic entry see Field 2F.
W88-09252

GROUND WATER MODELING APPLIED TO DETERMINING WELL LOCATIONS AND WELL FIELD YIELD, CERREJON COAL PROJECT, COLOMBIA, SOUTH AMERICA,
For primary bibliographic entry see Field 2F.
W88-09254

GROUND WATER MANAGEMENT MODEL FOR DESERT AQUIFERS,
Ohio Univ., Athens. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2F.
W88-09269

INFLUENCE OF VERTICAL VARIATIONS IN LITHOLOGY ON A MATHEMATICAL MANAGEMENT MODEL FOR THE OGALLALA AQUIFER, TEXAS COUNTY, OKLAHOMA,
For primary bibliographic entry see Field 4B.
W88-09270

USE OF A COMPUTER MODEL FOR GROUND WATER MANAGEMENT, EASTERN SAN JOAQUIN COUNTY, CALIFORNIA,
Brown and Caldwell, Sacramento, CA.
For primary bibliographic entry see Field 4B.
W88-09271

USING COMPUTER METHODS IN ISLAND WATER RESOURCE MANAGEMENT, VASHON/MAURY ISLAND, WASHINGTON,
For primary bibliographic entry see Field 4B.
W88-09274

GROUND WATER SAFE YIELD USING LOW-FLOW FREQUENCY ANALYSIS,
Boyle Engineering Corp., San Diego, CA.
For primary bibliographic entry see Field 4B.
W88-09277

DATA BASE MANAGEMENT SYSTEM APPROACH TO GROUND WATER MANAGEMENT,
For primary bibliographic entry see Field 4B.
W88-09279

EVIDENTIARY CONSIDERATIONS RELATED TO THE USE OF GROUND WATER MODELS IN LITIGATION,
Moses, Wittemyer, Harrison, and Woodruff, Boulder, CO.
For primary bibliographic entry see Field 6E.
W88-09280

INSTALLATION OF MULTI-LEVEL MONITORING WELLS IN A FRACTURED ROCK MEDIA,
Woodward-Clyde Consultants, Plymouth Meeting, PA.
For primary bibliographic entry see Field 7A.
W88-09286

CHEMICAL ANALYSIS OF WATER: GENERAL PRINCIPLES AND TECHNIQUES,
Water Research Centre, Medmenham (England). Medmenham Lab.
For primary bibliographic entry see Field 7B.
W88-09355

PRESENT-DAY HYDROLOGY OF THE RIVER SEVERN,
Severn-Trent Water Authority (England).
For primary bibliographic entry see Field 2E.
W88-09365

PALAEOHYDROLOGICAL SYNTHESIS AND APPLICATION,
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2A.
W88-09373

PRACTICAL QUALITY CONTROL OF RAINWATER ANALYSES,
College of William and Mary, Williamsburg, VA. Dept. of Chemistry.
S. Y. Tyree.
IN: Sampling and Analysis of Rain. A Symposium Sponsored by the American Society for Testing and Materials, Committee D-22 on Sampling and Analysis of Atmospheres, Philadelphia, Pennsylvania, October 7, 1981. ASTM Special Technical Publication 823, 1983. p 18-28, 5 fig, 11 tab, 11 ref.

Descriptors: *Water analysis, *Rain, *Data interpretation, *Quality control, *Acid rain, *Chemical analysis, Hydrogen ion concentration, Monitoring, Titration, Acidity.

A detailed picture is presented of the internal consistency of the data generated by a typical acid rain monitoring system. Three independent techniques may be applied in the assessment of rainwater acidity: pH measurement, titration, and charge balance. On the assumption that one solution can have only one acidity value, the three techniques present an excellent test for data consistency. Typical results from two extensive monitoring systems are shown. The difficulties inherent in the titration technique are: agreement on protocol, reagent impurities, carbon dioxide interference, and weak acid end point. It will be shown

that the titration technique is to be recommended in a very limited number of cases. The pH measurement technique is recommended provided it is understood that accuracy no worse than + or - 0.2 of a pH unit is acceptable. Methods of minimizing error are discussed. The charge balance method presumes the measurement of eight ions, minimum. Error sums and ultimate accuracy are described. Methodology recommendations are made. Practical results of analyses of real samples collected and analyzed by very inexperienced personnel under 'adequate' supervision are shown. (See also W88-09387) (Author's abstract)
W88-09390

STATE GROUND WATER DATA MANAGEMENT,
Sewall (James W.) Co., Old Town, ME.
For primary bibliographic entry see Field 4B.
W88-09482

FREQUENCY DISTRIBUTION OF THUNDERSTORM DURATIONS,
North Carolina Univ., Chapel Hill.
For primary bibliographic entry see Field 2B.
W88-09533

1 AUGUST 1981 CCOPE STORM: OBSERVATIONS AND MODELING RESULTS,
South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W88-09536

SAMPLING VARIATIONS OF HAILSTONE SIZE DISTRIBUTIONS,
Alberta Research Council, Edmonton. Resource Technologies Dept.
For primary bibliographic entry see Field 2B.
W88-09537

NUMERICAL FORECAST STUDIES OF THE OCTOBER 1987 STORM OVER SOUTHERN ENGLAND,
Meteorological Office, Bracknell (England).
For primary bibliographic entry see Field 2B.
W88-09649

REVIEW OF DENITRIFICATION IN ON-SITE WASTEWATER TREATMENT SYSTEMS,
Madrid Univ. (Spain). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W88-09663

LONGITUDINAL DISTRIBUTION OF RIVERINE BENTHOS: A RIVER DIS-CONTINUUM,
Minnesota Univ., St. Paul. Dept. of Forest Resources.
For primary bibliographic entry see Field 2H.
W88-09681

EXAMINATION OF ASSOCIATION INDICES AND FORMULATION OF A COMPOSITE SEASONAL DISSIMILARITY INDEX,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Fisheries Research Branch.
O. E. Johannsson, and K. C. Minns.
Hydrobiologia HYDRB8, Vol. 150, No. 2, p 109-121, July 20, 1987. 8 fig, 2 tab, 12 ref.

Descriptors: *Limnology, *Statistical methods, *Association indices, *Dissimilarity index, *Species composition, *Population dynamics, Lake Ontario, Seasonal variation, Comparison studies, Monitoring, Phytoplankton, Statistical analysis, Lakes.

A composite seasonal dissimilarity index (SD) is developed to compare systematically changing communities. Seven association indices were examined. Percent Dissimilarity was chosen for community comparisons because it retained a large percentile range for scaling dissimilar communities and responded linearly to the degree of overlap between communities. Examination of three consecutive years of Lake Ontario phytoplankton data, using SD, produced reasonable dissimilarity values. Inter-year variability was significantly greater than inter-station variability. SD has great potential in ecology for comparing communities which vary along any gradient. In use, all possible SD year-year combinations would be calculated and the results grouped to detect different groups of years thereby defining normal types of years as well as unusual years. This technique can detect slow drifts in community structure, cyclic changes and abrupt alterations. SD should be a valuable tool for long-term monitoring and community analysis. (Author's abstract)
W88-09689

INFLUENCES OF HABITAT AND SEASONAL SAMPLING REGIMES ON THE ORDINATION AND CLASSIFICATION OF MACROINVERTEBRATE ASSEMBLAGES IN THE CATCHMENT OF THE RIVER WYE, WALES,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
S. J. Ormerod.
Hydrobiologia HYDRB8, Vol. 150, No. 2, p 143-151, July 20, 1987. 1 fig, 6 tab, 34 ref.

Descriptors: *Sampling, *Aquatic habitats, *Seasonal variation, *Macroinvertebrates, *Aquatic populations, *Benthic fauna, *Species composition, Hydrogen ion concentration, Stream gradient, Principal component analysis, Correlation analysis, Wales, Water sampling, River basins, Computer programs.

Assemblages of benthic macroinvertebrates were assessed in relation to environmental variables at 45 sites in the catchment of the Welsh River Wye in 1982. Samples were collected from three habitats (margins, riffles, flats) and in two seasons (Spring and Autumn), separated and combined data sets being ordinated and classified by the computer programs DECORANA and TWINSPAN. Correlations between primary ordinations were high ($p < 0.001$) and always strongly related to total hardness or pH: secondary ordinations were also intercorrelated and were related to stream slope. In each instance, total hardness and slope were the strongest discriminants between site groupings produced by TWINSPAN. It is concluded that relationships between faunal assemblages, stream chemistry and stream physiography would be effectively detected in the Wye catchment in either Spring or Autumn and in each of the habitats sampled. However, the most precise categorization of assemblage type required a sampling strategy which combined habitat and seasonal data. (Author's abstract)
W88-09690

ENVIRONMENTAL FACTORS INFLUENCING THE OCCURRENCE OF JUVENILE FISH IN THE MANGROVES OF PAGBILAO, PHILIPPINES,
Open Univ. of Sri Lanka, Nawala. Dept. of Zoology.
For primary bibliographic entry see Field 2L.
W88-09696

INSTREAM FLOW STUDIES IN PERSPECTIVE,
Tulsa Univ., OK. Faculty of Biological Science.
For primary bibliographic entry see Field 6D.
W88-09720

FURROW FLOW MEASUREMENT ACCURACY,
Agricultural Research Service, Kimberly, ID.
T. J. Trout, and B. E. Mackey.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 244-255, May 1988. 2 fig, 3 tab, 13 ref, append.

Descriptors: *Furrow, *Flow measurement, *Streamflow measurements, *Irrigation, *Statistical analysis, Calibrations, Hydraulics, Error analysis irrigation.

The primary source of error in properly calibrated, constructed, and installed flow measurement devices is due to reading error or uncertainty. Head reading uncertainty in small V-notch flumes and submerged orifices is measured in the field as + or - 3mm with no consistent variation with reading. Elapsed time measurement uncertainty for volumetric measurements increases with the square root of the time. The sensitivity of flow measurement uncertainty to head or time reading uncertainty is proportional to the ratio of the device discharge equation exponent to the reading. Furrow flow measurement uncertainty varies with the device and flow rate, but generally exceeds + or - 5% and often exceeds + or - 10%. Maintaining uncertainty below + or - 10% requires flume measurements in the upper 50% of their range, orifice measurements with head readings > 13mm, and volumetric measurement elapsed times > 4 sec. (Author's abstract)
W88-09735

INFLOW-OUTFLOW INFILTRATION MEASUREMENT ACCURACY,
Agricultural Research Service, Kimberly, ID.
For primary bibliographic entry see Field 2G.
W88-09736

MUSKINGUM MODEL FOR BORDER IRRIGATION,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W88-09737

TRICKLE LATERAL HYDRAULICS: I. ANALYTICAL SOLUTION.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 3F.
W88-09738

TRICKLE LATERAL HYDRAULICS: II. DESIGN AND EXAMPLES,
Arizona Univ., Tucson. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W88-09739

FLOOD SKEW IN HYDROLOGIC DESIGN ON UNGAGED WATERSHEDS,
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W88-09740

EXTREME RAINFALL FOR AFRICA AND OTHER DEVELOPING AREAS,
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
For primary bibliographic entry see Field 2B.
W88-09742

SIMPLE METHOD OF OBTAINING SUBROOKS RETENTION PARAMETERS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 2G.
W88-09747

IMPACT ON THE SENJOGAHARA ECOSYSTEM OF EXTREME RUN-OFF EVENTS FROM THE RIVER SAKASAGAWA, NIKKO NATIONAL PARK: II. THE CORRELATION OF VEGETATION AND ENVIRONMENTAL DISTURBANCE USING TWINSPAN AND DCA ORDINATION TECHNIQUES,
Tokyo Univ. of Agriculture and Technology (Japan). Faculty of Agriculture.
For primary bibliographic entry see Field 2E.
W88-09771

OPTIMIZATION MODEL FOR ANALYSIS OF TEST PUMPING DATA,
Roorkee Univ. (India). School of Hydrology.
For primary bibliographic entry see Field 2F.
W88-09782

INFLUENCE OF OUTLYING OBSERVATIONS ON SELECTED ESTIMATES OF PARAMETERS OF DISTRIBUTIONS,
Environmental Monitoring Systems Lab., Las Vegas, NV.
R. Rajagopal.
Ground Water GRWAAR, Vol. 26, No. 3, p 325-332, May-June 1988. 4 fig, 3 tab, 14 ref. Environmental Protection Agency Cooperative Agreement CR 813552-01-0.

Descriptors: *Groundwater movement, *Statistics, *Frequency distributions, *Water quality, *Groundwater pollution, Drinking water, *Contamination, Mathematical analysis, Statistical analysis.

Most measures of groundwater quality are positively skewed with a few observations occurring with significantly large values. Using a set of mathematical expressions and readily available software, the effect of deleting one or more large-valued observation(s) on selected estimates of parameters on underlying distributions are evaluated. The effect of deleting a single large-valued observation on the mean is linear, and on the standard deviation it is nonlinear (approximately quadratic). In the case of multiple deletions, the relationship between the change in mean and the sum of the deleted observations is linear, whereas the relationship between the change in the standard deviation and the sum of deleted observations is nonlinear. The effect on the standard deviation is a function of the sum of squares of deleted observations. The standard deviation is much more sensitive to the magnitude of deleted observations than the mean. Analysis of a large data set consisting of 17 primary and secondary drinking water constituents showed that the effects of deleting large-valued observations on the standard deviation is considerably higher than that on the mean, the 95th and the 99th percentiles. Seldom are percentiles below the 75th affected by the deletion of large-valued observations. Analyses of upper quantiles and the maximum can be of much value in the study of maximum contaminant level violations and population exposure to toxic chemicals above and beyond certain threshold levels. Since large-valued observations affect the estimated of different parameters differently, it is extremely important to choose the relevant parameter first and then study the change in its estimate based on the deletion of large-valued observations. (Author's abstract)
W88-09786

TEST OF WEIGHTED USABLE AREA ESTIMATES DERIVED FROM A PHABSIM MODEL FOR INSTREAM FLOW STUDIES ON TROUT STREAMS,
Wyoming Game and Fish Dept., Cheyenne.
For primary bibliographic entry see Field 6D.
W88-09819

INVESTIGATION OF INTERANNUAL RAINFALL VARIABILITY IN AFRICA,
Wisconsin Univ., Madison. Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W88-09841

PREDICTION OF INDIAN MONSOON RAINFALL: FURTHER EXPLORATION,
Wisconsin Univ., Madison. Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W88-09842

OROGRAPHIC RAINFALL EVENTS IN THE OROFURE MOUNTAIN RANGE IN HOKKAIDO, JAPAN,
Hokkaido Univ., Sapporo (Japan). Dept. of Geophysics.
For primary bibliographic entry see Field 2B.
W88-09868

STATISTICAL RELATION BETWEEN RELATIVE HUMIDITY AND THE GMS OBSERVED CLOUD AMOUNT,
Japan Meteorological Agency, Tokyo. Numerical Prediction Div.
For primary bibliographic entry see Field 2A.
W88-09869

ESTIMATION OF ENVIRONMENTAL FATE OF INDUSTRIAL CHEMICALS,
Mitsubishi-Kasei Inst. of Toxicological and Environmental Sciences, Yokohama (Japan).
For primary bibliographic entry see Field 5B.
W88-09905

NONLINEAR, DISCRETE FLOOD EVENT MODELS: I. BAYESIAN ESTIMATION OF PARAMETERS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W88-09915

NONLINEAR, DISCRETE FLOOD EVENT MODELS: II. ASSESSMENTS OF STATISTICAL NONLINEARITY,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W88-09916

NONLINEAR, DISCRETE FLOOD EVENT MODELS: III. ANALYSIS OF PREDICTION UNCERTAINTY,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W88-09917

VARIABILITY IN BENTHIC INVERTEBRATE DENSITY ESTIMATES FROM STREAM SAMPLES,
Chadwick and Associates, Littleton, CO.
For primary bibliographic entry see Field 2H.
W88-09927

NORMALLY DISTRIBUTED SAPROBIC INDEX DATA FROM THE BLAGOEVGRADSKA BISTRITZA RIVER,
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
For primary bibliographic entry see Field 5A.
W88-09972

LOG-LOGISTIC FLOOD FREQUENCY ANALYSIS,
Saint Andrews Univ. (Scotland).
For primary bibliographic entry see Field 2E.
W88-09974

FACTORS AFFECTING THE IDENTIFICATION OF INDEPENDENT STORM EVENTS,
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
For primary bibliographic entry see Field 2B.
W88-09977

COMPARATIVE STUDY OF AREAL RAINFALL ESTIMATION METHODS USING RAIN GAGE AND RADAR DATA - APPLICATION TO DAILY RAINFALL EVENTS OBSERVED IN THE MONTREAL REGION (ESTIMATION DE LAMES D'EAU SPATIALES A L'AIDE DE DONNES DE PLUVIOMETRES ET DE RADAR METEOROLOGIQUE - APPLICATION AU PAS DE TEMPS JOURNALIER DANS LE REGION DE MONTREAL),
Institut de Mecanique de Grenoble, Saint-Martin d'Heres (France).
For primary bibliographic entry see Field 2B.
W88-09979

ASSESSMENT AND COMPILATION OF GROUNDWATER QUALITY DATA FOR MISSISSIPPI,
Mississippi State Univ., State College. Dept. of Civil Engineering.
D. D. Truax.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-186093. Price codes: A14 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G1234. Project No. USGS G1234-23. Mississippi Water Resources Research Institute, Mississippi State, Technical Completion Report G1234-23, July 1987. 290 p, 224 fig, 29 tab, 5 ref, 3 append.

Descriptors: *Mississippi, *Data collections, *Computer programs, *Water quality data, Data storage and retrieval, Water quality management, Groundwater management, Information management, Well data.

The State of Mississippi has a great reliance on its groundwater resources to supply water for drinking, agriculture and industry. Previously, that groundwater quality data in the state was stored primarily in paper files and virtually no water management or assessment use was made of this information. In recent years, the legislature of the State of Mississippi mandated the development of a centralized water database management system to help rectify this. This project was part of the initial response to this requirement. The primary task of this work was the compilation and electronic storage of the historic groundwater quality data. This was achieved by merging computerized data obtained from the U.S. Geological Survey with data from paper files of the Mississippi Departments of Health and Natural Resources. This effort consisted of correlating the State's information with federal well site information. Well over ten thousand paper data records were examined. A secondary objective was the development of a menu-driven, user-friendly, computer-based system which would allow data access and management. Further, the network of computer programs was to allow a remote user to manipulate the data in virtually any fashion desired. The end-product would be an electronic file which in turn could be down-loaded to a remote terminal, transferred to a second program which would develop printouts, or transferred to a third system for plotting of concentration contours. (Truax-MS St. Univ.)
W88-10027

JANUARY 1987 WATER LEVELS, AND DATA RELATED TO WATER-LEVEL CHANGES, WESTERN AND SOUTH-CENTRAL KANSAS,
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 2F.
W88-10046

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER, WEST-CENTRAL FLORIDA, MAY 1987,
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W88-10047

ANALYTICALLY-DERIVED SENSITIVITIES IN ONE-DIMENSIONAL MODELS OF SOLUTE TRANSPORT IN POROUS MEDIA,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-10048

CALIBRATION OF A DISSOLVED-SOLIDS MODEL FOR THE YAMPA RIVER BASIN BETWEEN STEAMBOAT SPRINGS AND MAYBELL, NORTHWESTERN COLORADO,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-10050

SURFACE WATER-QUALITY CHARACTERISTICS IN THE UPPER NORTH FORK GUNNISON RIVER BASIN, COLORADO,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-10051

GEOHYDROLOGIC AND SURFACE-WATER DATA FOR THE SACO RIVER VALLEY GLACIAL AQUIFER FROM BARTLETT, NEW HAMPSHIRE TO FRYEBURG, MAINE: OCTOBER 1983 THROUGH JANUARY 1986,
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 2F.
W88-10056

SELECTED WATER-QUALITY DATA FOR THE MINIDOKA IRRIGATION DISTRICT, SOUTH-CENTRAL IDAHO, JUNE 1987,
Geological Survey, Boise, ID. Water Resources Div.
H. W. Young, D. J. Parliman, and I. O'Dell.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Open-File Report (map) 87-465, 1987. 1 sheet.

Descriptors: *Maps, *Water quality, *Hydrologic data collections, *Nitrogen compounds, *Drinking water, *Groundwater contamination, Groundwater level, Nitrates, Idaho, Snake River Plain, Minidoka Irrigation District.

This map report presents June 1987 water-quality data, principally dissolved nitrite plus nitrate (as nitrogen), and depth-to-water measurements for 67 wells in the Minidoka Irrigation District, south-central Idaho. Nitrogen concentrations ranged from 0.2 to 76 milligrams per liter; the median concentrations was 6.6 milligrams per liter. Nitrogen concentrations in 9 samples exceeded the U. S. Environmental Protection Agency public drinking-water limit of 10 milligrams per liter. (USGS)
W88-10057

DIGITAL-MODEL SIMULATION OF THE AQUIFER SYSTEM I THE TOPPENISH CREEK BASIN, YAKIMA INDIAN RESERVATION, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W88-10058

GEOLOGY AND WATER RESOURCES OF CLARK COUNTY, SOUTH DAKOTA, PART II: WATER RESOURCES,
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 2F.
W88-10061

SURFACE-WATER-QUALITY ASSESSMENT OF THE UPPER ILLINOIS RIVER BASIN IN ILLINOIS, INDIANA, AND WISCONSIN: PROJECT DESCRIPTION,
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-10066

8. ENGINEERING WORKS

8A. Structures

FIRST EPA SUPERFUND CUTOFF WALL: DESIGN AND SPECIFICATIONS,
Goldberg-Zoino and Associates, Inc., Newton Upper Falls, MA.
For primary bibliographic entry see Field 5G.
W88-09131

ENVIROWALL VERTICAL CUTOFF BARRIER,
For primary bibliographic entry see Field 5G.
W88-09132

ISOLATION OF CONTAMINATED GROUND WATER BY SLURRY-INDUCED GROUND DISPLACEMENT,
For primary bibliographic entry see Field 5G.
W88-09133

USE OF WELL PACKERS TO CONTROL TCE AND PCE CONTAMINANTS,
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 5G.
W88-09278

ENGINEER'S MANUAL FOR WATER WELL DESIGN.
Moss (Roscoe) Co., Los Angeles, CA.
Roscoe Moss Company, Los Angeles, California. 1985. 242 p. 28 Fig, 2 append.

Descriptors: *Water wells, *Well drilling, *Wells, *Manuals, *Design standards, Drilling, Construction methods, Water supply development.

Declining water tables and more stringent water quality requirements increasingly necessitate exploitation of deeper and more complex aquifers. Longer surface casings and sealing to eliminate unusable groundwaters and surface contamination have become commonplace. These and other changing requirements, coupled with new technologies, have increased well design complexity. The purpose of the technical specification is to ensure implimentation of the well engineer's design. Specification errors have frequently resulted in a product unintended by the engineer, and occasionally in unusable wells. Lack of thoroughness may encourage bidding and work by contractors with unsuitable equipment and inadequate experience. Instead of presenting separate technical specifications for each drilling method, this manual discusses designs encompassing most high capacity wells and procedures for their construction. Illustrative sections from typical specifications are set forth where appropriate. Chapter 2 defines the ten most frequently used well designs and discusses their uses. Chapter 3 examines construction methods and relevant design factors. Following review of the material contained in these chapters and area and site evaluation, the engineer should prepare the basic well design. Later elements such as selection of screen opening and gravel gradation, methods of development, test pumping procedures, well appurtenances, etc., are covered in subsequent chapters and may be referred to as the specifications are written. The purpose of this publication is to assist an engineer not familiar with every facet of water well construction to avoid design errors and shoddy construction. This manual is only a guide, and modifications to meet a specific condition will be required. (Lantz-PTT)
W88-09353

WATER WELL HANDBOOK.
Missouri Water Well and Pump Contractors Association, Belle, MO.
Missouri Water Well and Pump Contractors Assoc., Inc., Belle, Missouri. 1984. 281 p. Edited by Keith E. Anderson.

Descriptors: *Water wells, *Wells, *Handbooks, Groundwater, Geohydrology, Drilling, Pipes, Pumps, Electricity, Hydraulics, Groundwater budget.

This handbook contains the charts, tables, and other data to which drillers, engineers and geologists frequently refer. Specifically, attempts were made to compile only the data applicable to groundwater supplies. Chapter discussions include: (1) quality of water; (2) cable tool drilling; (3) rotary drilling; (4) air rotary drilling; (5) pipe and casing; (6) pumps; (7) electrical data; and (8) geology and hydraulics of wells. (Lantz-PTT)
W88-09354

DESIGN AND CONSTRUCTION OF WATER WELLS: A GUIDE FOR ENGINEERS,
National Water Well Association, Worthington, OH.
J. Lehr, S. Hurlburt, B. Gallagher, and J. Voytek.
Van Nostrand Reinhold Company, New York. 1988. 229 p.

Descriptors: *Water wells, *Groundwater, *Well construction, *Wells, *Construction, *Design standards, Geohydrology, Drilling, Groundwater movement, Maintenance, Intake, Groundwater potential, Engineering.

This book provides fundamental knowledge about water-well construction that not only serves as a step toward understanding more complex material, but that applies to the water-well project at hand. Among the topics covered are these: (1) groundwater and geology; (2) drilling technology; (3) water well design; (4) constructing wells; and (5) water well maintenance. Other subjects covered include groundwater flow, intake design, testing for yield and quantity, water well development, consolidated rock wells, and groundwater regions of the United States. (Lantz-PTT)
W88-09356

ALTERNATIVE SEWER SYSTEMS.
Water Pollution Control Federation, Alexandria, VA.
For primary bibliographic entry see Field 5D.
W88-09357

HAND DRILLED WELLS: A MANUAL ON SITING, DESIGN, CONSTRUCTION AND MAINTENANCE,
Rwegarulila Water Resources Inst., Dar es Salaam (Tanzania).
For primary bibliographic entry see Field 2F.
W88-09400

USE AND PLACEMENT OF GROUTING AND SEALING MATERIALS,
Vermont Agency of Natural Resources, North Waterbury, VT.
For primary bibliographic entry see Field 5G.
W88-09517

FLOOD ALLEVIATION OF THE KAKEHASHI BASIN, JAPAN,
Kanazawa Inst. of Tech. (Japan). Dept. of Mechanical System Engineering.
For primary bibliographic entry see Field 4A.
W88-09729

REDEVELOPMENT OF CLOGGED RECHARGE WELLS,
Kuwait Fund for Arab Economic Development, Safat.
For primary bibliographic entry see Field 4B.
W88-09744

USING CENTER PIVOTS FOR RESEARCH,
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W88-09746

BOUNDARY-ELEMENT ANALYSIS FOR UNCONFINED SEEPAGE PROBLEMS,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W88-09957

8B. Hydraulics

CONSTRUCTION DEWATERING: A GUIDE TO THEORY AND PRACTICE,
Moretrench American Corp., Rockaway, NJ.
J. P. Powers.
John Wiley and Sons, New York. 1981. 484 p.

Descriptors: *Hydraulics, *Soil mechanics, *Groundwater movement, *Dewatering, *Con-

struction, *Environmental effects, Geohydrology, Aquifers, Pump tests, Chemical analysis, Pipes, Wells, Drains, Artificial recharge, Grouting, Fluid mechanics, Soil water, Chemical properties, Sumps, Deep wells, Costs.

The movement of groundwater through the soil and its effects are governed by laws of some complexity. The construction worker must have a degree of understanding of these laws before groundwater problems can be dealt with effectively. The book begins with a discussion of the theory on which construction dewatering is based. The theory involves the disciplines of soil mechanics, hydrology, geology, and fluid mechanics. The physical relationships in the book are presented without mathematical derivations. The engineer who wishes to confirm the mathematical validity of the relationships presented in this text will find references for further study. Chapter discussions include: the geology of soils; soils and water; hydrology of the ideal aquifer; characteristics of natural aquifers; hydrologic analysis of dewatering systems; pumping tests; groundwater chemistry; sumps, drains, and open pumping; deep well systems; grouting; artificial recharge; sand drains; and dewatering costs. (Lantz-PTT)
W88-08989

WATER TANK RECYCLED INTO A PUMP STATION - IN-HOUSE,
For primary bibliographic entry see Field 5F.
W88-09657

CHANNEL RESPONSE TO GRADE-CONTROL STRUCTURES ON MUDDY CREEK, MISSISSIPPI,
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
M. D. Harvey, and C. C. Watson.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 2, p 79-92, April-June 1988. 7 fig, 5 tab, 24 ref.

Descriptors: *Channel erosion, *Grade-control structures, *Channeling, *Channel morphology, *Water management, Water management effects, Morphology, Hydraulics, Hydraulic structures, Aggradation, Berms, Bed-load discharge, Shear stress, Water surface profiles, Allowable Tractive Stress Method, Design criteria, Muddy Creek, Mississippi.

Grade-control structures are commonly employed to prevent bed degradation and concomitant bank instability of channelized reaches of rivers. A study of a 20 km reach of Muddy Creek, a coastal plains stream in Mississippi, was conducted in 1985 to determine the effects of 12 rock-lined grade-control structures that were installed between 1977 and 1983 prior to channel excavation. An Allowable Tractive Stress Method (TR.25) was used to determine the placement of grade-control structures, and the gradients between them, for a trapezoidal-shaped channel designed to convey the 1 year recurrence interval peak flow. The design was successful in preventing bed degradation and bank erosion over the period of observation. However, unpredicted channel responses have occurred. Aggradation is apparent between control structures, and two-stage compound channel has formed as a consequence of berm development, especially in the lower, older subreach. In the lower subreach, the vegetated berms have constricted the cross-sectional area at the design discharge (99 cu m/second), and as a result, the water-surface slope, shear stress, and unit-stream power have increased. Bed material has become coarser and better sorted, which has increased shear intensity values. These unexpected changes are attributed to the lack of adequate consideration of the requirement for balance between sediment supply and transport in the TR.25 procedure; seven tributaries contribute sediment to the main channel of the study reach. It appears that the increased energy is utilized in bedload transport rather than channel erosion. It is demonstrated that the TR.25 method is too conservative if significant amounts of sediments are being supplied to the design channel. In such cases, adjustments in channel morphology will increase the energy to accommodate bedload transport. (Author's abstract)
W88-09719

SUSPENDED SOLIDS TRANSPORT IN THE REGULATED RIVER BLITHE, STAFFORDSHIRE, U.K.,
Birmingham Univ. (England). Dept. of Geological Sciences.
For primary bibliographic entry see Field 2J.
W88-09722

HYDRAULIC FRICTION FACTORS FOR PIPE FLOW,
Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
F. Z. Kamand.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH Vol. 114, No. 2, p 311-323, May 1988. 8 fig. 2 tab, 14 ref, 2 append.

Descriptors: *Pipe flow, *Friction, *Mathematical analysis, Hydraulic design, Flow friction, Hazen-Williams equation, Manning equation, Darcy-Weisbach equation, Computers, Design criteria.

Hydraulic friction loss in pipelines directly affects pipe and pump sizing, as well as the balance of networks. All friction head-loss equations have an uncertainty in the estimation of pipe interior surface roughness. When a single resistance coefficient based only on the pipe material is used, different equations may give significantly different estimates of frictional head losses depending on pipe size and water flow rate. In complex pipe network systems, minor differences in equations or coefficients may accumulate and result in vastly different predicted head losses or flow rates in individual pipes. Mathematical relationships and nomographs are presented that to relate the friction factors of three widely used pipe friction equations and to determine the magnitude of the differences in calculated head losses. Friction factors were developed to be used with the Hazen-Williams and the Manning equations for PVC and cast-iron pipes that give similar calculated head losses to those of the Darcy-Weisbach equation. The variation of the friction factors with diameter and flow conditions is presented, and computer implementation of the variable friction factors is discussed. (Author's abstract)
W88-09741

GENERALIZED ENERGY AND POTENTIAL ENSTROPHY CONSERVING FINITE DIFFERENCE-SCHEMES FOR THE SHALLOW WATER EQUATIONS,
National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies.
F. Abramopoulos.
Monthly Weather Review MRWEAB, Vol. 116, No. 3, p 650-662, March 1988. 1 fig, 1 tab, 6 ref, 3 append.

Descriptors: *Enstrophy, *Shallow water equations, *Mathematical studies, *Fluid mechanics, *Hydrodynamics, Finite difference method, Prediction, Topography, Energy, Flow, Mathematical, Streamflow.

The conditions under which finite difference schemes for the shallow water equations can conserve both total energy and potential enstrophy are considered. A method of deriving such schemes using operator formalism is developed. Several such schemes are derived for the A-, B- and C-grids. The derived schemes include second-order schemes and pseudo-fourth order schemes. The simplest B-grid pseudo-fourth-order schemes are presented. (Author's abstract)
W88-09873

8C. Hydraulic Machinery

LARGE SUBMERSIBLE WATER PUMP MANUAL: A GUIDE TO SELECTION, SIZING, INSTALLATION AND MAINTENANCE OF 6-INCH AND LARGER SUBMERSIBLES.
Water Systems Council, Chicago, IL.
Water Systems Council, Chicago, Illinois. 1986. 65 p, 15 fig, 12 tab, append.

Descriptors: *Pumps, *Manuals, Agriculture, Municipal water, Industrial water, Installation, Mathematical equations, Water conveyance, Water supply development.

The expanding use of 6-inch diameter and larger submersible water pumps for agricultural, municipal and industrial applications has created a need for this manual. Written for specifying and consulting engineers, contractors, installers and end-users, it features easy-to-use information on the selection, installation, and maintenance of 6-inch and larger submersible pumps. It introduces pumps, system components, and technical terms, as well as mathematical formulae and the steps in the proper selection and sizing of submersible pumps. It also includes a wide range of useful charts, illustrations and graphs for on-going reference. (Lantz-PTT)
W88-08983

HYDROCARBON RECOVERY PUMP FOR LOW TRANSMISSIVITY AQUIFERS,
Geoscience Consultants Ltd., Albuquerque, NM.
For primary bibliographic entry see Field 5G.
W88-08995

VERTICAL TURBINE, MIXED FLOW, AND PROPELLER PUMPS,
J. L. Dicmas.
McGraw-Hill Book Company, New York. 1987. 379 p.

Descriptors: *Pumps, *Propellers, *Turbines, Hydraulic machinery, Hydraulic design, mathematical equations, Hydraulic turbines, Hydraulic equipment, Hydraulic engineering, Design criteria, Design standards.

All aspects of vertical diffusion vane pumps in the range from 1,200 to 13,500 specific speed (0.44 to 5.00 type numbers), are discussed in this book, which is divided into four sections. Chapters 1 through 5 make up the first section and describe present standard vertical turbine, mixed flow, propeller pump, and submersible turbine pump construction. Design features of component parts are discussed with explanations as to why they are made the way they are. Definitions of terms and examples of calculations from bowl assembly to overall pump and motor performance are given. Equations for mechanical design of components are shown, with examples of calculations for axial thrust, shaft and column elongation, and lateral vibration, to name a few. Chapters 6, 7, and 8 comprise the second section. Chapters 6 and 7 describe the varieties of structures in which vertical pumps are installed as well as methods of installation, and Chapter 8 describes the operating techniques associated with vertical pumps such as managing back spin in deepwell turbine pumps and starting propeller pumps against closed discharge valves. The third section of the book (Chapter 9) is the extension of a design manual written some time ago and subsequently enlarged. It can be used for designing a completely new bowl assembly, fitting a new impeller into an existing bowl, or improving a current design. Finally, Chapter 10 covers laboratory and field testing with examples of facilities, measuring instruments, and test procedures. (Lantz-PTT)
W88-09239

REDUCTIONS IN ICHTHYOPLANKTON ENTRAINMENT WITH FINE-MESH, WEDGE-WIRE SCREENS,
Versar, Inc., Columbia, MD.
For primary bibliographic entry see Field 8I.
W88-09823

MIGRATION OF LANDLOCKED ATLANTIC SALMON SMOLTS AND EFFECTIVENESS OF A FISH BYPASS STRUCTURE AT A SMALL-SCALE HYDROELECTRIC FACILITY,
Cornell Univ., Ithaca, NY. Dept. of Natural Resources.
For primary bibliographic entry see Field 8I.

W88-09827

EFFECTS OF HYDROELECTRIC DEVELOPMENT AND FISHERIES ENHANCEMENT ON SPRING AND SUMMER CHINOOK SALMON AND STEELHEAD IN THE COLUMBIA RIVER BASIN,
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 8I.
W88-09828

SUSCEPTIBILITY OF CHINOOK SALMON TO BYPASS SYSTEMS AT HYDROELECTRIC DAMS,
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 8I.
W88-09829

ALTERNATIVE WATER SCREENING FOR THERMAL POWER PLANTS,
Burns and Roe, Inc., Oradell, NJ. Hydraulic Engineering Dept.
R. T. Richards.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 6, p 578-597, June 1988. 16 fig, 4 ref.

Descriptors: *Trash rakes, *Intakes, *Trash racks, *Screens, *Design standards, *Design criteria, Hydroelectric plants, Electric power production, Thermal powerplants, Economic aspects, Maintenance, Fouling.

Since the early 1900s, virtually the only water screen used for power-plant cooling water systems in the United States has been the 'through-flow' type of travelling screen. Trash bars and rakes upstream of the screens have been similarly restricted in design. Other industrialized countries of the world have gone their own separate ways in power plant water screening, having considerable confidence that they have the best. Serious and costly clogging and carryover of debris have plagued many U.S. installations over the years, but apparently not enough to push users to look at these other successful technologies. The common alternatives to through-flow screens are reviewed, with comments on the pros and cons of performance, maintenance, and cost. Some recent improvements to common U.S. screens are discussed. Alternative trash rake designs are similarly reviewed. Finally, variations in the total water-cleaning train are discussed. (Author's abstract)
W88-09849

DESIGN AND OPERATION OF ANGLED-SCREEN INTAKE,
New England Power Co., Westborough, MA.
For primary bibliographic entry see Field 8I.
W88-09850

BIOFOULING CONTROL AT WATER INTAKE STRUCTURES,
Stone and Webster Engineering Corp., Boston, MA.
Y. G. Mussalli.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 6, p 616-625, June 1988. 4 fig, 4 tab, 10 ref.

Descriptors: *Biofouling, *Intakes, *Coatings, *Chlorination, *Performance evaluation, *Design criteria, *Design standards, Thermal powerplants, Condensers, Maintenance.

Biofouling of water intakes can affect condenser performance and availability. Five biofouling control technologies are reviewed: thermal backwash; antifouling toxic coatings; nontoxic coatings; chlorination; and cathodic protection. Thermal backwash is currently used in power plants on the West Coast and on Long Island Sound. Toxic coatings, although effective, are currently restricted because of environmental concerns. Nontoxic coatings are currently being evaluated nationwide. Continuous low-level chlorination can be effective if it is distributed uniformly on intake surfaces. Cathodic protection has proven to be ineffective. (Author's abstract)
W88-09851

EFFECTIVENESS OF ANGLED-SCREEN INTAKE SYSTEM,
Environmental Services, Easton, CT.
For primary bibliographic entry see Field 8I.
W88-09852

BIOLOGICAL EVALUATION OF ANGLED-SCREEN TEST FACILITY,
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
For primary bibliographic entry see Field 8I.
W88-09853

HYDRO-POWER INTAKE DESIGN CONSIDERATIONS,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 8I.
W88-09854

PASSIVE INTAKE SYSTEM FOR SHALLOW SAND-BED RIVER,
Black and Veatch, Kansas City, MO.
J. C. Johnson, and R. Ettema.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 6, p 662-674, June 1988. 9 fig, 1 ref.

Descriptors: *Shallow water, *Rivers, *Bed sediments, *Sand, *Intakes, *Screens, *Design criteria, *Hydroelectric plant, Model studies, Ecological effects, Maintenance, River training, Kansas River, Sedimentation, Hydraulic models.

The Jeffrey Energy Center draws its cooling water makeup from the Kansas River, a shallow sand-bed river of constantly changing bottom geometry. To accommodate this withdrawal, the water intake system was designed to be capable of maintaining intake capacity at all river stages. A set of river training devices keeps the deepest part of the river near the intake. Water is withdrawn from the river through three cylindrical wedge-wire intake screens, passed to a sedimentation basin, and then pumped to the plant site. A reinforced-concrete trough installed along the face of the screen structure protects the intake screens from potentially damaging debris. The trough diverts debris from the intake screen and also reduces sedimentation in this region. Water jets periodically clean the trough. Before construction of the facility, the trough and water jet systems were modeled to confirm and refine this portion of the design. The intake is environmentally acceptable and requires little maintenance. (Author's abstract)
W88-09855

ASSESSMENT OF DEVELOPMENTAL NEEDS FOR ADVANCED INTAKE TECHNOLOGIES,
Stone and Webster Engineering Corp., Boston, MA.
Y. G. Mussalli, E. P. Taft, and W. Micheletti.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 6, p 675-688, June 1988. 4 tab, 18 ref, append.

Descriptors: *Screens, *Fish behavior, *Fish handling facilities, *Fish guiding, *Fish passages, *Intakes, *Hydroelectric plants, *Design criteria, *Design standards, *Economic aspects, Performance evaluation, Ecological effects, Maintenance, Barriers, Comparison studies.

Increasing fuel and construction costs of new power plants have emphasized the need to achieve cost-effective, highly reliable circulating water intake designs that can improve power plant availability and performance while meeting environmental requirements. Additional concerns are to reduce maintenance, improve hydraulic conditions, and control fouling, siltation, and ice. The present paper discusses an Electric Power Research Institute (EPRI)-sponsored study to assess the status of available intake technologies for fish protection and to develop a research program to evaluate and compare the operation, performance, cost, and reliability of selected fish protection systems. The initial assessment of the available behavioral barriers, physical barriers, collection and removal systems, and diversion systems identified for further study 11 of the most promising technologies. These 11 technologies were ranked as to the importance of various levels of specific design criteria and the importance among these criteria. The technologies were then matched with potential test sites. Biological and engineering test methodologies were developed, together with design schemes for behavioral barriers at each test site. As a result of the study, EPRI is testing behavioral barriers at several sites. EPRI also is collecting data from several existing intake facilities where angled screens, modified fish screens, and wedge-wire screens are being evaluated. (Author's abstract)
W88-09856

8D. Soil Mechanics

SLOPE STABILITY: GEOTECHNICAL ENGINEERING AND GEOMORPHOLOGY.
John Wiley and Sons, New York. 1987. 648 p. Edited by M. G. Anderson and K. S. Richards.

Descriptors: *Slope stability, *Geomorphology, *Geotechnology, Slope protection, Slope stabilization, Soil engineering, Model studies.

In order to appreciate the problems involved in the safety determination of a given slope, the engineer needs to understand the existence of quaternary slope development and fossil mass movement activity. The geomorphologist must also appreciate the range of parameters capable of incorporation into engineering stability analyses when applying these to regional problems of slope development. Therefore, the integration of geotechnical engineering and geomorphology is of prime importance in the overall understanding of slope stability. Thus, the coupling of geomorphological process models to engineering approaches is a major innovation, bringing together investigations of engineering problems and slope form, and providing the basis for the organization of this collection of essays. (See W88-09335 thru W88-09351) (Lantz-PTT)
W88-09334

MODELLING SLOPE STABILITY: THE COMPLIMENTARY NATURE OF GEOTECHNICAL AND GEOMORPHOLOGICAL APPROACHES,
Bristol Univ. (England). Dept. of Geography.
M. G. Anderson, and K. S. Richards.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 1-9, 27 ref.

Descriptors: *Slope stability, *Model studies, *Geomorphology, Slope stabilization, Soil engineering, Engineering, Geohydrology, Slopes.

There are three major elements involved in the analysis of slope stability. The first is the essentially static consideration, characterized by limit-equilibrium models, of the stability of specific slopes. The second element involves application of these models over short time-scales (seasonal, annual, or a few years), during which dynamic variability of external 'forcing' variables must be allowed for in the analysis - factors such as the slope hydrology, which causes transient peaks in soil moisture and pore pressure in relation to infiltration processes during rainstorms, or basal erosion which increases slope height and angle. Third, there is the application of stability analyses to the explanation of long-term slope evolution, over periods when it is necessary to make assumptions about the response of pore-water pressures to climatically induced variations in average and extreme slope hydrology conditions. A final, separate issue concerns the role of weathering, which constitutes a common concern for both the engineer and the geomorphologist. Although these elements involve the application of essentially similar models of slope stability, the problems of their calibration differ markedly. In the site-specific case, it is normal to assume fixed oil strength properties, worst-case hydrological

and therefore pore water pressure conditions, and two-dimensional representation of the failure surface. The two overriding concerns are with the selection of an appropriate stability analysis, and with data reduction - that is, with the choice of relevant parameters from a wide range of potentially available data. In the engineering context, there is a considerable potential data base which is rarely exploited in full, and simplifying assumptions are generally acceptable. Engineering solutions are given flexibility by the imposition of conservative factors of safety, and it is therefore possible to make assumptions about input data which could in fact be measured. The geomorphologist concerned with long-term stability problems is, however, concerned with predicting conditions at failure, and therefore for a factor of safety of unity. The model output requirement is therefore more rigorous, although the consequences of error are less dramatic. (See also W88-09334) (Lantz-PTT)
W88-09335

COMPARATIVE REVIEW OF LIMIT EQUILIBRIUM METHODS OF STABILITY ANALYSIS,
Bristol Univ. (England). Dept. of Civil Engineering.
D. Nash.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 11-75, 43 fig, 6 tab, 70 ref.

Descriptors: *Soil properties, *Slope stability, *Mathematical analysis, Linear analysis, Soil engineering, Slopes, Embankments, Excavation, Geohydrology, Groundwater, Equilibrium.

The limit equilibrium methods (linear methods: infinite slope analysis, wedge analysis, circular arc methods; non-linear methods: Bishop's routine method, Janbu's simplified method, Spencer's method, Morgenstern and Price's method, Janbu's rigorous analysis) are widely used for the analysis of slopes, embankments, and excavations. Although at first sight each method may appear to be quite different, the only significant difference is the assumption made about the position and inclination of the interslice forces. It is important to understand the theoretical basis of a particular method before applying it in practice. With the exception of the ordinary method of slices, extensive experience suggests that the methods are useful and reliable if they are applied appropriate. A thorough site investigation is essential to establish the soil and groundwater conditions, followed by careful soil testing in a reputable laboratory. The geotechnical specialist responsible for the project should be closely involved at all stages of the investigation so that minor details are not overlooked. Once the soil and groundwater conditions have been established, a method of analysis may be chosen which is appropriate to the anticipated mechanism of failure. It is often useful to ascertain the sensitivity of the result of the analysis to small changes in the assumed parameters so that engineering decisions may be based on a full understanding of the problem. (See also W88-09334) (Lantz-PTT)
W88-09336

INSTRUMENTATION OF PORE PRESSURE AND SOIL WATER SUCTION,
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 7B.
W88-09337

SLOPE STABILITY ANALYSIS INCORPORATING THE EFFECT OF SOIL SUCTION,
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
D. G. Fredlund.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 113-144, 31 fig, 10 tab, 25 ref.

Descriptors: *Slope stability, *Soil suction, *Mathematical analysis, Slopes, Shear strength, Pore pressure, Interstitial water, Soil water, Case studies.

For situations where the groundwater table is deep or where the concern is over the possibility of a shallow failure, there is need to understand how to perform slope stability analyses where the soil is unsaturated. The developments in slope stability analysis that incorporate the effect on strength of suction in the unsaturated zone are discussed. In order to maintain an analytical procedure for unsaturated soil mechanics, several aspects must be addressed. First, it must be possible to measure appropriate shear strength parameters for the unsaturated soils. Preferably these should provide a smooth transition to the saturated shear strength parameters. Second, techniques must be available to measure or estimate the in situ negative pore water pressure conditions. If an assessment of the factor of safety is required for a particular instant in the history of the slope, it is possible either to measure the suction in situ or on laboratory samples. The problem becomes more demanding when it is necessary to predict possible changes in the soil suction profile throughout the seasons. Third, the conventional, limit equilibrium, slope stability analysis must be extended to incorporate the shear strength equation for unsaturated soils. Once verified through a series of case histories, the method of slope stability analysis for unsaturated soils becomes an extension of the procedure used for saturated soils. (See also W88-09334) (Lantz-PTT)
W88-09338

IMPLICATIONS OF JOINTS AND STRUCTURES FOR SLOPE STABILITY,
Leeds Univ. (England). Dept. of Earth Sciences.
S. R. Hencher.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 145-186, 33 fig, 4 tab, 87 ref.

Descriptors: *Slope stability, *Rock joints, *Hydraulic structures, *Shear strength, Soil engineering, Stereographic analysis, Mathematical analysis, Water pressure, Groundwater, Water pressure.

The presence of discontinuities in rock and soil masses considerably affects their engineering properties and generally imposes markedly anisotropic strength. Slope stability analysis in such materials is dominated by the need to identify, measure, and analyze potentially failing blocks delineated by discontinuities. The importance of geological knowledge to all site investigations lies in the geologist's ability to recognize and establish the geological structure on the basis of limited data. This allows him to predict and extrapolate the nature of materials away from the point of observation. A table of discontinuity types has been presented to aid in their recognition in the field and in assessing their probable nature. The shear strength of persistent rock joints can be measured providing representative samples of joint surfaces are available. Impersistence and hence true cohesion of rock joints is however, difficulty to assess and further research is needed into how this property can be estimated. Groundwater pressures in jointed masses are often complex and require careful instrumentation to allow them to be measured with an acceptable degree of accuracy. This is probably one of the weakest aspects of most investigations and care should be taken to carry out preliminary analysis prior to instrumentation to ensure that pertinent information is collected. Methods of analysis for jointed rock and soil differ from those for 'homogeneous' and 'isotropic' soil in that the failure shape must be identified physically in the field rather than searched for mathematically. Stereographic analysis is particularly useful for identifying potential failure blocks from a mass of data on discontinuities. Numerical methods are now available to analyze quite complex wedge shapes allowing components of strength, weight, external loading, water pressure, and preventive or remedial works to be taken into account. (See also W88-09334) (Lantz-PTT)
W88-09339

VEGETATION AND SLOPE STABILITY,
Hong Kong Public Works Dept. Geotechnical Control Office.
D. R. Greenway.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 187-230, 35 fig, 14 tab, 121 ref.

Descriptors: *Slope stability, *Vegetation, *Slopes, Interception, Infiltration, Transpiration, Dessication, Roots, Hydraulic structures, Case studies, Hong Kong.

Vegetation that may be growing on a slope has traditionally been considered to have an indirect or minor effect on stability, and it is usually neglected in stability analyses. This assumption is not always correct, and for certain forested slopes with relatively thin soil mantles, it has been shown to be significantly in error. The relationships between interception, infiltration, transpiration, dessication, root systems, and anchoring, buttressing and arching, and slope vegetation and stability, are discussed. Case studies present data from Hong Kong to further the discussion of these topics. (See also W88-09334) (Lantz-PTT)
W88-09340

MODELLING THE EFFECTIVENESS OF A SOIL-CEMENT PROTECTIVE COVER FOR SLOPES,
Bristol Univ. (England). Dept. of Geography.
M. G. Anderson, and J. M. Shen.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 231-264, 20 fig, 12 tab, 32 ref.

Descriptors: *Slope stability, *Slope stabilization, *Model studies, *Soil stability, *Soil cement, *Soil water, Infiltration, Permeability, Rainfall, Chunam, Simulation analysis.

A model was formulated to predict the effectiveness of covering a slope with a material designed to reduce or eliminate surface infiltration and hence improve slope stability. While the model was developed for these specific artificial surfaces, the general framework can also be applied to slopes having naturally developed surface crust. The principal findings can be summarized as follows: (1) A model has been outlined which predicts flow through cracks under specified conditions; (2) This model can be used to estimate the effective permeability of chunam with cracks; (3) From a field crack survey, chunam effective permeability was predicted for poor to average chunam condition cover; (4) From the standpoint of rainfall intensity, an effective chunam permeability of 1,000,000 m/s or less needs to be achieved; (5) Selected factors have been outlined which may serve to reduce or increase the effective permeability of chunam for a specific crack distribution. These are factors such as vertical crack irregularity and void space at the chunam-soil interface that are not modelled; (6) The effective permeability of 1,000,000 m/s renders the slope soil water conditions independent of rainfall intensity and, consequently, only dependent on rainfall duration; and (7) Whether 1,000,000 m/s is a sufficiently low effective permeability to render the underlying soil free from saturation under specific rainfall duration recurrence intervals, can only be answered by reference to simulation studies undertaken by the soil water model. (See also W88-09334) (Lantz-PTT)
W88-09341

GROUNDWATER MODELS FOR MOUNTAIN SLOPES,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 2F.
W88-09342

EARTHQUAKE-PRONE ENVIRONMENTS,
Bari Univ. (Italy). Ist. di Geologia Applicata e Geotecnia.
V. Cotecchia.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 287-330, 27 fig, 57 ref.

Descriptors: *Seismic properties, *Slope stability, *Earthquakes, *Landslides, Slope degradation,

Mathematical analysis, Tectonics, Convergence, Landslides, Seismology.

Underlying the most common definition of the word earthquake, is the theory of plate tectonics. There may be three types of relative movement among plates: divergence, sideways slip, and convergence. In convergence, the plates meet and subduction occurs, with one plate disappearing beneath another. In both convergence and sideways slip, there is an enormous build-up of potential energy, and when the induced stresses exceed the strength of the material the strata involved rupture and a shear or slip surface (fault) is produced or reactivated. Falls and slips, and mass movements on steep slopes in general are triggered even by weak shocks of short duration but high frequency. Landslides in cohesive materials occur only as a result of strong, long-duration shocks, while even stronger tremors are needed to mobilize flows or complex movements such as debris avalanches produced by rock falls. In seismically-active areas, the preparation of landslide hazard maps is an essential prerequisite for proper seismic zoning of a region. Zoning of an area according to the landslide hazard calls for consideration of a wide variety of factors affecting slope stability, including lithological conditions, geological structure, seismicity, climatic conditions, vegetation cover, groundwater conditions, soil strength parameters, presence of old slides, and the actions of man. Pseudostatic methods and dynamic analysis of stability analysis under seismic loading conditions are discussed and summarized mathematically and graphically. (See also W88-09334) (Lantz-PTT)
W88-09343

BASAL EROSION AND MASS MOVEMENT,
Cambridge Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-09344

GENERAL MODELS OF LONG-TERM SLOPE EVOLUTION THROUGH MASS MOVEMENT,
Leeds Univ. (England). School of Geography.
M. J. Kirkby.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 359-379, 11 fig, 25 ref.

Descriptors: *Mass wasting, *Mass movement, *Slope stability, *Model studies, *Slopes, *Simulation analysis, Slope stabilization, Topography, Rockslides, Landslides, Weathering, Geotechnology.

A particular problem in simulating slope development by mass movements is their large individual size. A single movement can have a large enough impact on the slope profile to influence strongly the course of subsequent development, by changing topography and thence loadings and pore water distributions. In an aggregate model, the influence of individual events will inevitably be largely suppressed, so that their particular influence on the subsequent course of development will be lost. Long-term models are, therefore, likely to be most effective for mass movements in which individual events are small. Although models have not been developed to date for many kinds of mass movements, and flow slides in particular are poorly represented, there have been a number of attempts at modeling slope evolution through mass movements, either on their own or in combination with associated slower processes. The greatest amount of work has been on rock fall and the associated talus accumulation, both for humid and arid slopes, and this is described in one section of this chapter. Another section describes alternative approaches to soil landslides and a model which combines them with slow processes, while the final section considers the relationships between landslides and weathering rates, both as a guide to long-term landslide rates and through the development of changing geotechnical properties over time. (See also W88-09334) (Lantz-PTT)
W88-09345

MODELLING INTERRELATIONSHIPS BETWEEN CLIMATE, HYDROLOGY, AND HYDROGEOLOGY AND THE DEVELOPMENT OF SLOPES,
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
R. A. Freeze.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 381-403, 10 fig 2 tab, 30 ref.

Descriptors: *Slope degradation, *Geomorphology, *Hydraulic models, *Slope stability, *Geohydrology, *Climates, *Soil water, Rainfall intensity, Mathematical models, Mathematical studies, Permeability coefficient, Infiltration, Pore pressure, Soil properties, Slopes, Rainfall rate, Rainfall-runoff relationships, Runoff.

Relationships were derived that show the effect of rainfall rates and durations, hillslope geometry, and soil properties on the maximum stable slope angle of geomorphic landforms. The analysis included token consideration of the mechanisms of surface runoff and detailed consideration of the mechanisms of subsurface pore pressure development. This idealized analysis invoked deterministic climates, homogeneous soils, simple slope geometries, and analytical geohydrological solutions. The results show that a wide variation of response by slope angle can be expected in similar soils due to differences of climatic regime, and to differences of soil properties in similar climatic regimes. Saturated hydraulic conductivity was identified as a parameter of some importance in that it plays the dual role of controlling the runoff mechanism on the surface and the pore pressure development at depth. In many of the relationships between soil properties, climatic variables, and slope angles, there are regions of great sensitivity and others of relative insensitivity. Because slopes represent an integrated reaction between past climates and existing soil properties, it may be possible to use slope-angle measurements as an indication of past climate in regions of insensitivity to soil types or as an indirect measure of soil properties in regions of insensitivity to climate. (See also W88-09334) (Lantz-PTT)
W88-09346

WEATHERING EFFECTS: SLOPES IN MUDROCKS AND OVER-CONSOLIDATED CLAYS,
Durham Univ. (England). School of Engineering and Applied Science.
For primary bibliographic entry see Field 2J.
W88-09347

QUICK CLAYS,
Carleton Univ., Ottawa (Ontario). Dept. of Geography.
J. K. Torrance.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 447-473, 8 fig, 5 tab, 67 ref.

Descriptors: *Quick clay, *Soil properties, *Landslides, *Slope stability, Materials engineering, Cementation, Weathering, Soil consolidation, Geomorphology.

Quick clays are defined in terms of their sensitivity (the ratio of the undisturbed to the remolded shear strength) and their remolded shear strength, as those soils exhibiting a sensitivity > 30 and having a remolded shear strength < 0.5 kPa. The high sensitivity and, in particular, the fluidity of the remolded (or failed) soil material make the quick clays particularly susceptible to landslide activity and dramatic geotechnical failures. Requirements for quick clay development discussed are: (1) flocculated structure; (2) material properties; (3) salt removal; (4) dispersing agents; (5) cementation; (6) weathering; and (7) minimal consolidation and slow load increase. The presence of quick clay has important implications for slope stability and landslide geomorphology. Knowledge of quick clay behavior is critical to sensible development and land use in areas where it occurs. Land use regulations must take its existence into account and while it might be desirable to avoid all construction on quick clays, the large areas involved and their location make this impossible. (See W88-09334) (Lantz-PTT)
W88-09348

MASS MOVEMENT IN SEMI-ARID ENVIRONMENTS AND THE MORPHOLOGY OF ALLUVIAL FANS,
Minnesota Univ., Minneapolis. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2J.
W88-09349

MECHANISMS OF MASS MOVEMENT IN PERIGLACIAL ENVIRONMENTS,
University Coll., Cardiff (Wales). Dept. of Geology.
For primary bibliographic entry see Field 2J.
W88-09350

SLOPE DEVELOPMENT THROUGH THE THRESHOLD SLOPE CONCEPT,
S. C. Francis.
IN: Slope Stability: Geotechnical Engineering and Geomorphology. John Wiley and Sons, New York. 1987. p 601-624, 9 fig, 2 tab, 80 ref.

Descriptors: *Soil properties, *Slope stability, *Slopes, *Slope development, Model studies, Geohydrology, History, Evolution, Paleohydrology, Geomorphology.

A series of unresolved problems which are relevant to stability modelling are directly related to: the nature of thresholds, slope attributes, slope evolution and soil attributes, and slope evolution and hydrology. It is evident that the state-of-the-art is insufficiently precise to allow sweeping evolutionary statements to be made. However, in the short term, site-specific studies indicate that mass movement can control the form of steep slopes, but inevitably evolutionary interpretations become more speculative over longer time-scales. This is a particular problem as most studies of slope development have been made in temperate regions where paleoclimates have been variable: perhaps this variability can be minimized by looking in more detail at slopes which have evolved under more constant environmental conditions. (See also W88-09334) (Lantz-PTT)
W88-09351

PERMEABILITY AND COMPRESSIBILITY OF SLURRIES FROM SEEPAGE-INDUCED CONSOLIDATION,
Universidad Politecnica de Cataluna, Barcelona (Spain).
For primary bibliographic entry see Field 5E.
W88-09958

8E. Rock Mechanics and Geology

IMPLICATIONS OF JOINTS AND STRUCTURES FOR SLOPE STABILITY,
Leeds Univ. (England). Dept. of Earth Sciences.
For primary bibliographic entry see Field 8D.
W88-09339

KARST GEOMORPHOLOGY,
Australian National Univ., Canberra.
J. N. Jennings.
Basil Blackwell Inc., New York. 1985. 293 p.

Descriptors: *Geomorphology, *Karst, Rock formations, Landforms, Limestone, Drainage, Weathering, Karst hydrology, Caves, Geohydrology.

Limestone rock formations (and those of other soluble rock) provide some of the world's most interesting landforms. This book treats in detail, the nature, origin and evolution of both surface and underground landforms, and discusses the landforming processes, especially the hydrological ones, of limestone countries. Chapters discuss: karst rocks, karst processes, drainage, surface weathering, surface landforms, caves, cave deposits, the influence of geological structure, the influ-

ence of climate, coast and karst, and the historical geomorphology of karst. (Lantz-PTT)
W88-09352

ROCK PERMEABILITY OR HYDRAULIC CONDUCTIVITY - AN OVERVIEW,
Law Engineering Testing Co., Marietta, GA.
For primary bibliographic entry see Field 2F.
W88-09437

8F. Concrete

GUIDE TO THE SELECTION OF CEMENT, BENTONITE AND OTHER ADDITIVES FOR USE IN MONITOR WELL CONSTRUCTION,
California Regional Water Quality Control Board, Sacramento. Central Valley Region.
For primary bibliographic entry see Field 7B.
W88-09010

CEMENT BENTONITE GROUT AND ITS EFFECT ON WATER QUALITY SAMPLES: A FIELD TEST OF VOLCLAY GROUT,
For primary bibliographic entry see Field 7B.
W88-09011

8G. Materials

GUIDE TO THE SELECTION OF MATERIALS FOR MONITORING WELL CONSTRUCTION AND GROUND-WATER SAMPLING,
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 7B.
W88-08972

FATIGUE-CRACK PROPAGATION BEHAVIOR OF ASTM A27 CAST STEEL IN SIMULATED HANFORD GROUNDWATER,
Westinghouse Hanford Co., Richland, WA.
L. A. James.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-009519. Price codes: A04 in paper copy, A01 in microfiche. September 1986. 35 p, 13 fig, 13 tab, 33 ref, 2 append. Contract No. DE-AC06-76FF02170. Report No. HEDL-7603.

Descriptors: *Radioactive waste disposal, *Cracks, *Pressure effects, Temperature effects, *Groundwater pollution, *Materials engineering, *Storage tanks, *Steel, Mechanical failure, Materials testing, Waste management, Fatigue, Corrosion, Hanford, Washington.

An initial series of fatigue-crack growth tests have been conducted on ASTM A27 cast steel, a candidate Basalt Waste Isolation Project nuclear waste container material, in simulated Hanford groundwater at 150 and 250 C. Ancillary tests were also conducted on this steel in vacuo to determine the mechanical component of crack growth rates, thereby allowing calculation of the environmental component. The results showed that fatigue-crack propagation (FCP) rates in GR-4 groundwater appear to be slightly higher at 150 C than at 250 C. This may be related to the higher rates of general corrosion at 150 C. FCP rates in GR-4 groundwater do not appear to be strongly frequency (time) dependent at either 150 C or 250 C. A threshold for the environmental component of crecking is observed in GR-4 groundwater. Below this threshold, crack growth rates in GR-4 are approximately equivalent to those in vacuo, while above the threshold, the growth rates rise relatively rapidly with increasing values of the stress intensity factor (K). Tentative values of the threshold, corresponding to 95% confidence interval values, are 16.25 MPa/m (14.79 ksi/in) and 15.74 MPa/m (14.32 ksi/in) at 150 and 250 C, respectively. An example is given whereby the above tentative threshold value at 250 degrees is rephrased in terms of allowable combinations of stress and initial flaw size for the repository container. (Author's abstract)
W88-09085

8I. Fisheries Engineering

WATER POLLUTION AND FISH PHYSIOLOGY,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W88-09236

POTENTIAL FOR FISHERIES REHABILITATION IN THE HAMILTON HARBOUR-COOTES PARADISE ECOSYSTEM OF LAKE ONTARIO,
Toronto Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 5G.
W88-09546

EFFECTS OF SHELLSAND ON WATER QUALITY AND MATURE BROWN TROUT (EFFEKT AV SKJELLSAND PA VANNKVALITET OG KJONNSMODEN AURE),
Fylkesmannen i Vesfold, Miljovernavd, Toensberg (Norway).
For primary bibliographic entry see Field 5G.
W88-09699

NEPHROPS NORVEGICUS: FIELD STUDY OF EFFECTS OF OXYGEN DEFICIENCY ON HAEMOCYANIN CONCENTRATION,
Copenhagen Univ. (Denmark). Marine Biological Lab.
For primary bibliographic entry see Field 2L.
W88-09731

TROUT FARMS CAUSING DISTURBANCE IN THE NATURAL STREAM CONTINUUM (STOERUNG DES NATUERLICHEN LAENGSGRADIENTEN EINES BERGBACHES DURCH FORELLENTEICHANLAGEN),
Gesamthochschule Essen (Germany, F.R.). Lehrstuhl fuer Hydrobiologie.
V. S. Darschnik, and H. Schumacher.
Archiv fuer Hydrobiologie AHYBA4, Vol. 110, No. 3, p 409-439, September 1987. 8 fig, 2 tab, 67 ref.

Descriptors: *Aquaculture, *Trout, *Fish farming, *Limnology, *Water pollution sources, Species composition, Benthic fauna, Nutrients, Organic matter, Temperature, Ponds.

The impact of fish farms, inserted into mountain streams, was investigated by quantitative methods. The fish ponds change the temperature regime, increase the load of nutrients and organic matter and, consequently, alter the benthic zoocoenosis. The species composition drastically changes from above to below the ponds; the functional feeding groups shift from a shredder and grazer dominated community to detritus and filter feeders. Thermal, trophic and saprobiological status as well as the functional feeding groups change in that particular section in a way that naturally occurs within the longitudinal (time and space dependent) stream continuum. This effect can therefore be described as an upstream dislocation of downstream parts of the natural stream continuum. (Author's abstract)
W88-09756

LIMNOLOGICAL CHARACTERISTICS OF THE AREAS OF CAPTURE OF 'MANJUBA' ANCHOVIELLA LEPIDENTOSTOLE (FOWLER, 1911) (OSTEICHTHYES, ENGRAULIDAE), IN RIBEIRA DE IGUAPE RIVER FROM REGISTRO (SP) (CARACTERISTICAS LIMNOLOGICAS DE AREAS DE CAPTURA DE MANJUBA ANCHOVIELLA LEPIDENTOSTOLE (FOWLER, 1911) (OSTEICHTHYES, ENGRAULIDAE), NO RIO RIBEIRA DE IGUAPE, EM REGISTRO (SP)),
Instituto de Pesca, Santos (Brazil). Secao de Aquicultura.
For primary bibliographic entry see Field 2H.
W88-09774

LIMNOLOGICAL AND CLIMATOLOGICAL STUDY OF PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP, WITH THE INTENT TO POPULATE ITS RIVERS WITH THE RAINBOW TROUT, SALMO IRIDEUS GIBBONS (ESTUDO LIMNOLGICO E CLIMATICO DA REGIAO DO PARQUE ESTADUAL DE CAMPOS DO JORDAO, SP, COM VISTAS AO POVOAMENTO COM TRUTA ARCO-IRIS, SALMO IRIDEUS GIBBONS),
Instituto de Pesca, Santos (Brazil). Secao de Limnologia.
For primary bibliographic entry see Field 2H.
W88-09779

EFFECT OF AN OIL-CAKE (BRASSICA LATIFOLIA) PISCICIDE ON THE PHYSICO-CHEMICAL AND BIOLOGICAL SPECTRUM OF WATERBODIES,
Kalyani Univ. (India). Dept. of Zoology.
B. B. Jana, A. K. Manna, and G. Kundu.
Limnologica (Berlin) LMNOA8, Vol. 18, No. 2, p 431-439, December 1987. 4 fig, 1 tab, 8 ref.

Descriptors: *Piscicides, *Fisheries, *Fish farming, *Pesticide toxicity, *Bicarbonates, Chlorides, Phosphates, Fish ponds, Nitrogen compounds, Fertilizers, Phytoplankton, Zooplankton, Mohua oil cake.

Application of an organic piscicide (Brassica latifolia) at a dosage of 2500 kg/ha resulted in acidic and anaerobic conditions within 16 h to 4 days in both fish ponds and outdoor tanks. The mean values of bicarbonate, total hardness, chloride, phosphate and different forms of nitrogen were greatly increased in concentrations in treated waters compared to normal ones. Both phyto- and zooplanktons in nursery pond and phytoplankton in tanks were sharply decreased in numbers after day 3-5 of the mohua oil cake treatment; a sharp peak was noticed after week 2 of treatment. Among the zooplankters, copepods were most susceptible to the toxicity of mohua treatment, while rotifers and Euglenophyta were highly responsive to the manural effect of mohua treatment. (Author's abstract)
W88-09815

ESTIMATING THE DAILY PASSAGE OF JUVENILE SALMONIDS AT MCNARY DAM ON THE COLUMBIA RIVER,
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
A. E. Giorgi, and C. W. Sims.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 2, p 215-222, Spring 1987. 5 fig, 2 tab, 19 ref. U.S. Army Corps of Engineers contracts DACW57-83-F-0314, DACW65-78-C-0051, and DACW68-78-C-0051.

Descriptors: *Fish migration, *Fish passages, *Dams, Steelhead, Salmon, Smolt, Bypass system, Powerplants, Fisheries, Fish management, Columbia River, Washington.

The U.S. National Marine Fisheries Service, under contract to the U.S. Army Corps of Engineers, monitored the seaward migration of juvenile salmonids through the Snake-Columbia river system from 1973 to 1983. A procedure was developed for estimating the numbers of steelhead Salmo gairdneri and yearling chinook salmon Oncorhynchus tshawytscha smolts passing McNary Dam each day in 1982-1983. The method utilized the fingerling collection and. bypass system contained within the powerhouse. Freeze-branded groups of smolts released upstream from the dam were used to calibrate the efficiency with which migrants were collected over a range of powerhouse discharge levels. Application of collection efficiency calibration curves enabled researchers and fisheries managers to generate daily estimates of smolt passage as a function of the amount of water discharged through the powerhouse and the number of fish collected in the bypass system. (Author's abstract)
W88-09816

TROUT PRODUCTION AND STANDING CROP IN COLORADO'S SMALL STREAMS,

AS RELATED TO ENVIRONMENTAL FEATURES,
Colorado Cooperative Fishery Research Unit, Fort Collins.
D. L. Scarnecchia, and E. P. Bergersen.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 3, p 315-330, Summer 1987. 4 fig, 10 tab, 39 ref.

Descriptors: *Stream fisheries, *Aquatic productivity, *Trout, *Colorado, *Fish populations, Biomass, Water properties, Conductivity, Alkalinity, Hardness, Elevation, Water depth, Aquatic environment, Aquatic habitats.

Annual production of trout (Salvelinus and Salmo spp.) in 10 small northern Colorado streams ranged from 1.5 to 18.4 g/sq m in 1979 and 1980. Midsummer biomass ranged from 3.9 to 28.2 g/sq m. Ratios of production to biomass ranged from 0.23 to 0.95. Fish production and biomass were related inversely to elevation and directly to substrate diversity, conductivity, alkalinity, and water hardness. Combinations of the various factors explained much of the variation in production: elevation and width:depth ratio, 60%; elevation and substrate diversity, 54%; elevation, substrate diversity, and percentage of zero-water-velocity stations, 79%; and elevation, width:depth ratio, and alkalinity, 77%. Similar relationships were developed for midsummer biomass. There was a strong correlation between midsummer biomass and annual production as well as between annual production and the density of fish of desirable size (152 mm long or longer) in each stream. Several relationships are proposed from these data sets that can be used to predict trout production in small, high-elevation streams. Estimated habitat quality indices for the 11 sections were significantly related to midsummer biomass of trout in 1979 but not in 1980. (Author's abstract)
W88-09817

TEST OF WEIGHTED USABLE AREA ESTIMATES DERIVED FROM A PHABSIM MODEL FOR INSTREAM FLOW STUDIES ON TROUT STREAMS,
Wyoming Game and Fish Dept., Cheyenne.
For primary bibliographic entry see Field 6D.
W88-09819

EFFECTS OF RIPRAP BANK REINFORCEMENT ON JUVENILE SALMONIDS IN FOUR WESTERN WASHINGTON STREAMS,
Fish and Wildlife Service, Olympia, WA. Fisheries Assistance Office.
E. E. Knudsen, and S. J. Dilley.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 3, p 351-356, Summer 1987. 1 fig, 3 tab, 15 ref.

Descriptors: *Stream fisheries, *Salmon, *Trout, *Bank protection, *Flood control, Erosion control, Riprap, Washington.

Summer and fall juvenile salmonid populations in five pairs of stream sections were estimated shortly before and after construction of flood and erosion control projects. All five projects included bank reinforcement with rock riprap and three included streambed alterations. Juvenile coho salmon Oncorhynchus kisutch, juvenile steelhead Salmo gairdneri, and cutthroat trout Salmo clarki were apparently adversely affected by construction in the three smaller, and most severely altered, stream sections. Numbers of juvenile coho salmon and young-of-the-year trout were reduced somewhat, but those of yearling steelhead and cutthroat trout apparently increased, in the two newly riprapped sections of larger streams. Negative short-term effects of construction appeared to increase with severity of habitat alteration, to decrease with increase in stream size, and to decrease with increasing fish size. (Author's abstract)
W88-09820

EFFECTS OF VARIABLE STREAMFLOWS ON GROWTH OF SMALLMOUTH BASS IN THE MAQUOKETA RIVER, IOWA,
Iowa Dept. of Natural Resources, Manchester. Northeast District Headquarters.
V. L. Paragamian, and M. J. Wiley.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 3, p 357-362, Summer 1987. 2 fig, 3 tab, 21 ref.

Descriptors: *Stream fisheries, *Bass, *Fish populations, Growth, Streamflow, Fish diets, Maquoketa River, Iowa.

An investigation was conducted to compare instantaneous growth rates (G) of age-1 through -4 smallmouth bass Micropterus dolomieui to flow (Q) in the Maquoketa River, Iowa. The study site was below an inactive hydroelectric dam. Instantaneous growth rates varied primarily as a function of body size. Residual variation in growth had a clear unimodal distribution with respect to Q for age-1 fish. The relationship between G and Q was best described by logarithmic transformation of the deviations of Q from optimum flow. Nonlinear regression techniques were used to estimate optimal values of Q; the optimum was 10 cu m/s for age-1 fish. No clear relationships were evident for older age-classes (2-4) examined individually. We suspect that deleterious effects on the invertebrate prey (primarily aquatic insects) of young smallmouth bass is the best explanation for negative effects on growth when flow deviates from optimal values. Larger (and older) smallmouth bass have a more varied diet and larger energy reserves, and were apparently less affected by variations in Q. Average flows in the Maquoketa River during the smallmouth bass growing season are frequently <10 cu m/s. Smallmouth bass populations in this and similar rivers would benefit greatly if human activities did not further reduce flows. (Author's abstract)
W88-09821

USE OF ZOOPLANKTON SIZE TO ASSESS THE COMMUNITY STRUCTURE OF FISH POPULATIONS IN FRESHWATER LAKES,
Cornell Univ., Ithaca, NY. Dept. of Natural Resources.
E. L. Mills, and D. M. Green.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 3, p 369-378, Summer 1987. 6 fig, 3 tab, 26 ref.

Descriptors: *Lake fisheries, *Limnology, *Fish populations, Zooplankton, Predator-prey balance, New York.

The relationship between mean size of zooplankton and fish community structure was examined in 35 New York lakes. The study lakes contained fish populations dominated by percids, centrarchids, or both,, and were categorized based on fish species composition and the ratio of predators to panfish. An increase in the predator-to-panfish ratio was matched by an increase in zooplankton size, indicating that zooplankton size represents a suitable index of predator-prey balance. Mean zooplankton size also decreased as the abundance of age-0 fish increased and increased when the predator:panfish ratio increased after a successful introduction of piscivores. To assess fish community structure from mean size of crustacean zooplankton, it is recommended that sampling for zooplankton be done once in the spring and once in midsummer. (Author's abstract)
W88-09822

REDUCTIONS IN ICHTHYOPLANKTON ENTRAINMENT WITH FINE-MESH, WEDGE-WIRE SCREENS,
Versar, Inc., Columbia, MD.
S. B. Weisberg, W. H. Burton, F. Jacobs, and E. A. Ross.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 3, p 386-393, Summer 1987. 2 fig, 3 tab, 24 ref.

Descriptors: *Fish management, *Entrainment, *Screens, *Intakes, *Electric powerplants, Ichthyoplankton, Anchovy, Carp, Goby, Powerplants.

The exclusion efficiency of cylindrical wedge-wire screens was investigated at the Chalk Point Steam Electric Station in Aquasco, Maryland, by measuring entrainment of larval bay anchovies Anchoa mitchilli and naked gobies Gobiosoma bosci through screens with slot sizes of 1, 2, and 3 mm and through an unscreened intake. The degree of exclusion by the screens increased with fish size. Fish <5 mm long were not excluded by any of the screens. In contrast, >80% of larger ichthyoplankton were excluded by all screens. Virtually no ichthyoplankton >10 mm were entrained through the 1-mm screen even when fish of this size were abundant and were entrained through the unscreened intake. The 2-mm and 3-mm-slot screens were not as effective at excluding ichthyoplankton as the 1-mm screen, but the effect of slot size on exclusion efficiency was small relative to the effect of fish size. These results suggest that entrainment through water intake structures can be successfully reduced by wedge-wire screens if the larval fish at risk exceed 5 mm in length. (Author's abstract)
W88-09823

INFLUENCE OF HYDRILLA ON HARVESTABLE SPORT-FISH POPULATIONS, ANGLER USE, AND ANGLER EXPENDITURES AT ORANGE LAKE, FLORIDA,
Florida Univ., Gainesville. Dept. of Fisheries and Aquaculture.
D. E. Colle, J. V. Shireman, W. T. Haller, J. C. Joyce, and D. E. Canfield.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 3, p 410-417, Summer 1987. 2 fig, 3 tab, 18 ref. Environmental Protection Agency grant R-805497.

Descriptors: *Sport fishing, *Aquatic weeds, *Aquatic weed control, *Fish populations, Bass, Crappie, Bluegill, Sunfish, Economic aspects, Orange Lake, Florida.

An infestation of hydrilla (Hydrilla verticillata) caused an 85% reduction in angler effort at Orange Lake, Florida, in 1977 when plant coverage exceeded 80% of the lake. Nonlocal anglers were only 3% of the total number of anglers fishing the lake in 1977 but were 37% of the anglers during 1978 and 1979, when hydrilla coverage was <19%. Although angler use of Orange Lake was greatly reduced during the peak 1977 hydrilla infestation, the number of fish caught per hour during 1977 was equivalent to or greater than that of all study years for all species of sport fish. The almost complete plant coverage did not lower the population of harvestable largemouth bass Micropterus salmoides or black crappie Pomoxis nigromaculatus. Numbers of harvestable bluegill Lepomis macrochirus and redear sunfish Lepomis microlophus were, however, negatively correlated with hydrilla coverage. Reduction in angling caused a 90% loss in revenue from the Orange Lake sport fishery that is valued at approximately $1 million (U.S.) annually. Benefit:cost (B:C) ratios of sport-fishing expenditures to aquatic plant control costs during the 2 years in which there were no major aquatic problems were estimated to be 300:1 and 69:1. The B:C ratio decreased to 1:1 when hydrilla severely limited access to the lake. Excessive growth of hydrilla, which limited access to Orange Lake, tripled the aquatic plant control costs. These data are offered as an economic case for the control of nuisance aquatic vegetation because the total economic benefits far exceeded the cost of aquatic plant control. (Author's abstract)
W88-09824

CORRELATIONS OF REGULATED LAKE LEVELS AND CLIMATIC FACTORS WITH ABUNDANCE OF YOUNG-OF-THE-YEAR WALLEYE AND YELLOW PERCH IN FOUR LAKES IN VOYAGEURS NATIONAL PARK,
Voyageurs National Park, International Falls, MN.
L. W. Kallemeyn.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 4, p 513-521, Fall 1987. 2 fig, 2 tab, 23 ref.

Descriptors: *Lake fisheries, *Fish populations, *Fish management, *Water management, *Water level fluctuations, Walleye, Perch, Water level, Climate, Water temperature, Air temperature,

Wind velocity, Spawning, Voyageurs National Park, Minnesota.

The relationships between year-class strengths of walleye Stizostedion vitreum and yellow perch Perca flavescens, as determined from seine catches of young of the year, and regulated lake levels, air and water temperatures, and wind velocities during the spawning period of both species were studied in 4 lakes in Voyageurs National Park, MInnesota, from 1981 through 1985. Significant positive correlations were found between lake level and walleye year-class strength in 3 of the 4 lakes sampled. The correlation between lake level and yellow perch year-class strength, while generally positive, was significant in only one lake. Significant positive correlations were also found between thermal conditions during the 30-d period following ice-out and year-class strengths of walleye and yellow perch; the strongest year classes of both species were produced in years with higher, more stable temperatures. An alternative water management scheme is proposed that may enhance walleye and yellow perch reproductive success by providing higher lake levels earlier in the spring. (Author's abstract)
W88-09825

EFFECTS OF STOCKING HYBRID STRIPED BASS IN SPRING LAKE, ILLINOIS,
Western Illinois Univ., Macomb. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W88-09826

MIGRATION OF LANDLOCKED ATLANTIC SALMON SMOLTS AND EFFECTIVENESS OF A FISH BYPASS STRUCTURE AT A SMALL-SCALE HYDROELECTRIC FACILITY,
Cornell Univ., Ithaca, NY. Dept. of Natural Resources.
D. C. Nettles, and S. P. Gloss.
North American Journal of Fisheries Management NAJMDP, Vol. 7, No. 4, p 562-568, Fall 1987. 3 fig, 2 tab, 21 ref. U.S. Department of Energy agreement DE-AI05-840R21416.

Descriptors: *Fish management, *Fish migration, *Trash racks, *Bypass channels, *Hydroelectric plants, *Telemetry, Dams, Radiotelemetry, Water temperature, Salmon smolt, Spillways, Penstocks, River flow, Boquet River, New York.

Downstream movements by smolts of Atlantic salmon Salmo salar were monitored with radiotelemetry to assess the effectiveness of an angled trash rack and fish bypass structure at a small hydroelectric dam on the Boquet River, New York. Telemetry of 170 Atlantic salmon smolts and visual observations of stocked smolts were used to determine aspects of migration behavior. Smolts began mass migrations after river temperatures reached or exceeded 10 C. Many radio-tagged smolts interrupted movements upon reaching ponded waters or the dam. River flow did not affect the frequency of migratory movements, dam passages, or rate of movement ($P>0.05$). Migrations lasted approximately 30 d. Passages at the dam occurred primarily at night (61%); diurnal passages (17%) and crepuscular passages (17%) were of secondary importance, and timing of 5% of the passages was undetermined. All passages were through the bypass or over the spillway when angled trash racks were in place. Six passages occurred when trash racks perpendicular to the penstock were in place; three of these were penstock passages. The angled trash rack and bypass structure significantly reduced entrainment through the penstock and turbine ($P<0.05$). (Author's abstract)
W88-09827

EFFECTS OF HYDROELECTRIC DEVELOPMENT AND FISHERIES ENHANCEMENT ON SPRING AND SUMMER CHINOOK SALMON AND STEELHEAD IN THE COLUMBIA RIVER BASIN,
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
H. L. Raymond.
North American Journal of Fisheries Management NAJMDP, Vol. 8, No. 1, p 1-24, Winter 1988. 6 fig, 7 tab, 49 ref.

Descriptors: *Fish migration, *Fish passages, *Columbia River, *Snake River, *Dams, *Hydroelectric plants, Salmon, Steelhead, Smolt, Reservoirs, Bypass channels, Spillways, Fisheries, Fish management, Fish populations, Water temperature, Mortality, Animal diseases, Bacterial infection, Kidneys.

Trends in abundance of spring and summer chinook salmon Oncorhynchus tshawytscha and steelhead Salmo gairdneri returning to the Snake River and the mid-Columbia River above Priest Rapids Dam were determined by analyzing the percentage of adults returning from the smolt out-migrations of 1962-84. Runs declined as a result of hydroelectric development of the river; the main cause for the decline was the mortality of juveniles migrating downstream through as many as 9 dams and impoundments en route to the ocean. Mid-Columbia River summer chinook salmon runs experienced the greatest decline because of higher mortalities incurred during their migration to sea as subyearlings in July and August. Mortality was lower for remaining races of fish that migrate to the sea as yearlings in the spring during higher river flows, more spill at dams, and cooler water temperatures. Enhancement measures to offset dam-related mortality of smolts began in 1970 on the Snake River and in 1975 on the mid-Columbia River. These measures included increased numbers of smolts released from hatcheries, spillway deflectors to reduce dissolved gas saturation, fingerling bypasses at dams, transportation of smolts around dams, supplemental river flows to minimize delay for smolts passing through reservoirs, and supplemental spill at dams to minimize turbine mortality of smolts at dams without fingerling bypasses. These actions have reversed the decline of steelhead but not of salmon. Enhancement has improved the rate of return of wild spring chinook salmon, but wild fish contribution is minimal at this time because stocks were reduced by earlier hydroelectric development. Runs are mostly of hatchery origin and have not responded well to enhancement. Mortality of hatchery fish may be due to activation of bacterial kidney disease by stresses encountered during downriver migrations, transportation, or subsequent transition into seawater. (Author's abstract)
W88-09828

SUSCEPTIBILITY OF CHINOOK SALMON TO BYPASS SYSTEMS AT HYDROELECTRIC DAMS,
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
A. E. Giorgi, G. A. Swan, W. S. Zaugg, T. Coley, and T. Y. Barila.
North American Journal of Fisheries Management NAJMDP, Vol. 8, No. 1, p 25-29, Winter 1988. 2 fig, 1 tab, 15 ref.

Descriptors: *Fish migration, *Fish passages, *Dams, *Hydroelectric plants, *Bypass channels, Salmon, Steelhead, Smolt, Screens, Gills, Enzymes, Snake River, Fisheries, Fish management, Fish physiology, Columbia River.

Several hydroelectric dams in the Snake-Columbia river system are equipped with submersible traveling screens that project into the turbine intakes. The screens are designed to divert juvenile migrant Pacific salmon Oncorhynchus spp. and steelhead Salmo gairdneri from the intake upward into gatewells and the adjoining central bypass system. Assays of gill Na,K-ATPase were performed on yearling chinook salmon O. tshawytscha collected during routine fish guidance efficiency tests in 1985 and 1986. On three of the four sampling dates, Na,K-ATPase levels were significantly higher in fish guided into the gatewell than in those not guided. These data suggest a relationship between the physiological status of smolting yearling chinook salmon and their susceptibility to guidance by traveling screens. Assessments of salmonid outmigrations may be biased if they are based on samples from traveling guidance systems. (Author's abstract)
W88-09829

EFFECTS OF VARIATION IN FLOW ON DISTRIBUTION OF NORTHERN SQUAWFISH IN THE COLUMBIA RIVER BELOW MCNARY DAM,
Fish and Wildlife Service, Cook, WA. Willard Field Station.
M. P. Faler, L. M. Miller, and K. I. Welke.
North American Journal of Fisheries Management NAJMDP, Vol. 8, No. 1, p 30-35, Winter 1988. 6 fig, 2 tab, 8 ref. Bonneville Power Administration contracts DI-AI79-82BP34796 and DE-AI79-84BP35097.

Descriptors: *Fish migration, *Fish passages, *Hydroelectric plants, *Dams, *Flow velocity, *Bypass channels, Squawfish, Salmon, Spillways, Telemetry, Mortality, Fisheries, Fish management, Predation, Columbia River.

The movements of 23 northern squawfish Ptychocheilus oregonensis were monitored by radiotelemetry below a Columbia River hydroelectric dam during the out-migration of juvenile anadromous salmonids in 1984 and 1985. The work was done as part of a study to relate predator abundances and distribution to juvenile salmonid mortalities associated with dams. Northern squawfish remained in protected shoreline areas in spring and early summer, when discharge rates were high, but moved close to the dam and the juvenile bypass outflow area in mid to late summer, when discharge rates were low. Trends in fish movements were similar during abrupt changes in discharge rate. During short-term closures of the spillway, when flow patterns were abruptly changed, 4 of 5 fish moved out of protected areas and into the main river channel. Surface water velocities at 81 locations occupied by radio-tagged fish in June to August 1985 ranged from 0 to 70 cm/s (mean, 24.5 cm/s). No preference within this range was evident, but the fish seemingly avoided areas of high current velocity, because they did not move into a substantial portion of the tailrace where water velocities exceeded 100 cm/s. Modification of structures to maintain high water velocities around bypass outflow areas should reduce potential predation on juvenile salmonids by northern squawfish. (Author's abstract)
W88-09830

USE OF GABION WEIRS TO IMPROVE SPAWNING HABITAT FOR PINK SALMON IN A SMALL LOGGED WATERSHED,
Poulin (V.A.) and Associates Ltd., Vancouver (British Columbia).
H. D. Klassen, and T. G. Northcote.
North American Journal of Fisheries Management NAJMDP, Vol. 8, No. 1, p 36-44, Winter 1988. 3 fig, 5 tab, 24 ref.

Descriptors: *Fisheries, *Fish management, *Spawning, *Gabions, *Weirs, Salmon, Dissolved oxygen, Fish egg survival, Streams, Gravel.

Tandem V-shaped gabion weirs for improving spawning habitat for Pacific salmon Oncorhynchus spp. were installed to replace large organic debris at three sites in Sachs Creek, Queen Charlotte Islands, British Columbia. Intragravel conditions were compared between three gabion weir pairs and six nearby reference sites. Survival of eggs of pink salmon O. gorbuscha was compared between one gabion pair and two reference sites. The improvement in intragravel dissolved oxygen depression (surface-intragravel concentrations) after gabion installation (a decrease from 5.4 mg/L before to 2.5 mg/L after installation) was significant ($P<0.05$) when compared to changes found at nearby reference sites. Intragravel permeability also improved significantly ($P<0.05$) after gabion installation in the low-gradient (1%) reaches of Sachs Creek (from 870 cm/h before to 2,400 cm/h after installation). Pink salmon egg survival calculated by two indices at one gabion site in its first year of operation did not differ significantly ($P>0.05$) from survival at two nearby reference sites. Gabions appear to be useful tools for the restoration of damaged streams. (Author's abstract)
W88-09831

DESIGN AND OPERATION OF ANGLED-SCREEN INTAKE,
New England Power Co., Westborough, MA.
M. R. Anderson, J. A. DiVito, and Y. G. Mussalli.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 6, p 598-615, June 1988. 17 fig, 5 ref.

Descriptors: *Fish passages, *Intakes, *Angled-screen intakes, *Fish handling facilities, *Screens, *Design standards, *Design criteria, Thermal powerplants, Performance evaluation, Ecological effects, Maintenance, Larvae, Fish guiding, Brayton Point, Massachusetts, Costs.

A new angled-screen intake was constructed in 1984 at the Brayton Point Generating Station Unit 4 to protect fish and larvae and to allow the use of a once-through cooling system. The intake features low approach velocity, 1-mm fine-mesh screens, flush angled screens with fish buckets, and low-pressure sprays. The installation of the angled-screen structure has proven to be an economical option for operation of Unit 4 at Brayton Point Station in an open-cycle mode, while providing maximum protection for marine organisms. This protection has been accomplished by modifying standard intake traveling screen and arranging them to suit fish swimming patterns while adding fish pumps for the bypassing of fish and provisions for impingement release of nonguiding species. (Alexander-PTT)
W88-09850

EFFECTIVENESS OF ANGLED-SCREEN INTAKE SYSTEM,
Environmental Services, Easton, CT.
S. J. Edwards, J. Dembeck, T. E. Pease, M. J. Skelly, and D. Rengert.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 6, p 626-640, June 1988. 4 fig, 5 tab, 10 ref.

Descriptors: *Fish passages, *Screens, *Thermal powerplants, *Fish guiding, *Intakes, *Design criteria, *Fish handling facilities, Performance evaluation, Ecological effects, Seasonal variation, Traveling screens, Maintenance, Survival, Lake Ontario, New York, Pumps.

The Unit 6 intake system at Niagara Mohawk Power Corporation's Oswego Steam Station Unit 6 is designed to mitigate periodic losses of lake Ontario fish by bypassing and returning to the lake those fish that enter the offshore intake. Fish are diverted along four traveling water screens installed in a chevron arrangement angled with respect to the flow. Jet pumps provide bypass flow necessary for fish return to the lake. Three years of information on the operational and biological effectiveness of the angled-screen fish diversion system are presented and discussed. System components are discussed in terms of maintenance requirements and operation relative to an adjacent conventional intake system (Unit 5). Hydraulic measurements are also presented. Biological effectiveness of this system is compared with that of a once-through system with conventional vertical traveling screens. Evaluation of fish survival up to 96 hr after diversion indicates seasonal and species-specific survival. (Author's abstract)
W88-09852

BIOLOGICAL EVALUATION OF ANGLED-SCREEN TEST FACILITY,
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
J. A. Matousek, T. E. Pease, J. G. Holsapple, and R. C. Roberts.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 6, p 641-650, June 1988. 1 fig, 3 tab, 6 ref.

Descriptors: *Fish guides, *Fish handling facilities, *Fish passages, *Screens, *Intakes, *Hydroelectric plants, *Design criteria, Entrainment, Maintenance, Plankton, Fry, Larvae, Hudson River Estuary, Performance evaluation, Survival.

A three-year study sponsored by the Empire State Electric Energy Research Corporation was conducted to determine the diversion efficiency and survival of adult and larval fish at a full-scale angled screen demonstration facility located on the Hudson River estuary. A total of 59,309 fish were collected during the three-year study, 99.4% from the diversion flow. Initial survival was 90.2%. Extended survival following a 96-hr observation period was 35.3%. The angled-screen system efficiency was 31.6%, increasing to 84.3% when corrected for collection and handling mortality. Ichthyoplankton (yolk-sac, post-yolk-sac, and juvenille stages) diversion efficiency of 16.3% was inversely related to angled screen approach velocity and directly related to the size of the organism. Angled-screen system efficiency for ichthyoplankton was 1.7%. The angled-screen was judged to be successful for mitigating fish impingement. Ichthyoplankton study results indicate low diversion and high mortality, suggesting that angled screens are not effective for mitigating entrainment. (Author's abstract)
W88-09853

HYDRO-POWER INTAKE DESIGN CONSIDERATIONS,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
P. L. Johnson.
Journal of Hydraulic Engineering JHEND8, Vol. 114, No. 6, p 651-661, June 1988. 3 fig, 33 ref.

Descriptors: *Fish passages, *Penstocks, *Intakes, *Design criteria, *Design standards, *Hydroelectric plants, Performance evaluation, Gates, Trash racks, Survival, Maintenance, Hydraulic loss, Fish guiding, Fish handling facilities, Ice, Sediment control.

This paper presents a brief overview of factors to be considered in the design of hydropower penstock intakes. The paper notes areas of design concern including hydraulic losses, size and complexity of the intake within the associated gates and accessory equipment, the potential for air-entraining vortex formation, release water quality control through selective withdrawal, gate design, stoplog design, trashrack design, fish diversion and passage, ice control and exclusion, and sediment control and exclusion. Alternative design approaches with recommended design criteria are given. Specific examples that illustrate successful and unsuccessful designs are discussed and referenced. Specific concerns or deviations associated with high head, and pumped storage intakes are noted. It is intended that through use of th initial guidance given by this paper and the more detailed investigations generated, an appropriate, well-conceived intake design can be achieved. (Author's abstract)
W88-09854

ASSESSMENT OF DEVELOPMENTAL NEEDS FOR ADVANCED INTAKE TECHNOLOGIES,
Stone and Webster Engineering Corp., Boston, MA.
For primary bibliographic entry see Field 8C.
W88-09856

9. MANPOWER, GRANTS AND FACILITIES

9D. Grants, Contracts, and Research Act Allotments

FISCAL YEAR 1986 PROGRAM REPORT (MINNESOTA WATER RESOURCES RESEARCH CENTER).
Minnesota Univ., St. Paul. Water Resources Research Center.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88 164751/AS. Price codes: A04 in paper copy; A01 in microfiche. Report No. G1025-01, August 1986. 62 p. Contract No. 14-08-0001-G1233-01. Project No. USGS G1233-01.

Descriptors: *Water Research Institutes, *Research, *Information transfer, *Training, *Minnesota, Water quality, Groundwater, Groundwater contamination, Wetlands, Wastewater treatment, Lake hydrology, Waste management.

This report summarizes activities of the University of Minnesota Water Resources Research Center for fiscal year 1986, covering the period July 1, 1986 through June 30, 1987. The report describes the Center's information transfer and coordination activities, its involvement in training water resources scientists and engineers and results of research projects sponsored by the Center. During this period, the Center funded seven projects through its federal grant program. Three projects that received federal funds in previous years were completed during the year but did not receive FY 87 funds. In addition, the Center sponsored one project out of its internal funds and coordinated a large project funded from state sources. The Center cosponsored a workshop on waste management in Minnesota and published several technical and public information reports, along with a quarterly newsletter. (USGS)
W88-10000

FISCAL YEAR 1986 PROGRAM REPORT (ILLINOIS WATER RESOURCES CENTER),
Illinois Univ., Urbana. Water Resources Center.
G. F. Stout.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164454/AS. Price codes: A03 in paper copy; A01 in microfiche. Annual Report No. 22, Report No. G1223-01, August 1987. 23 p. Contract No. 14-08-0001-G1223. Project No. USGS G1223-01.

Descriptors: *Water Resources Institutes, *Illinois, *Research, *Training, *Information transfer, Pesticides, Agricultural runoff, Water pollution control, Risks, Genotoxins, Flood forecasting, Reservoir operations, Nutrient loss, Groundwater, Fertilizers, Water table.

The Water Resources Center selects projects for funding on the basis of scientific merit and relevance to the total water program of Illinois. In FY 1986, one project studied ways to control the runoff of pesticides from cropland. Another project is developing a risk assessment model for direct-acting genotoxins. The incorporation of uncertainty into real-time flood forecasting methodology was completed as a part of a doctoral dissertation. A second doctoral project was completed on the reliability of reservoir operation under hydrologic uncertainty and published as Research Report No. 207. The fifth study involved an evaluation of the nutrient loss to groundwater under fertilized row crops with a controlled water table. In addition State funds were used to support five additional projects. These dealt with an analysis of lake water quality improvement by paying farmers to abate nonpoint-source pollution, the development of an algal aquatic environmental monitor for detecting direct-acting and plant-activated genotoxins and carcinogens in lakes and streams, in-situ bioreclamation of contaminated groundwater, solar-driven catalytic oxidation of dilute organic compounds in groundwater, and factors affecting the microbial clogging of soils associated with water recharge. (USGS)
W88-10002

FISCAL YEAR 1986 PROGRAM REPORT (FLORIDA WATER RESOURCES RESEARCH CENTER),
Florida Univ., Gainesville. Water Resources Research Center.
P. Heaney.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164462/AS. Price codes: A03 in paper copy; A01 in microfiche. Program Report G1218-01, September 1986. 22 p, 13 ref. Contract No. 14-08-0001-G1218. Project No. USGS G1218-01.

Descriptors: *Research, *Information transfer, *Training, *Florida, *Water Resources Institutes, Stormwater models, Flood hazards, Water quality, Model studies, Computer models.

The 1986 Annual Center Report for Florida describes current water problems and issues of Florida. Also, it contains synopses of the following studies which were supported by this program: (1) Computer-Aided Engineering Approach to Urban Flood Hazard Management, by Wayne Huber; (2) An Expert System for Integrated Flood Hazard Mitigation in Florida, by Soro Nnaji and Andrew Dzurik; and (3) Computer-Aided Approach to Agricultural Flood Hazard Management in Florida, by Lloyd Baldwin, Del Bottcher, and Ken Campbell. These two year studies were completed this year. Seven reports were published in 1986. 'Runoff', the semi-annual newsletter, was sent to more than 1100 readers including 170 faculty. Lastly, technology transfer activities, cooperative arrangements with other groups, and training accomplishments are described. (Heaney-FL,WRRC)
W88-10003

FISCAL YEAR 1986 PROGRAM REPORT (D.C. WATER RESOURCES RESEARCH CENTER),
District of Columbia Univ., Washington. Water Resources Research Center.
M. H. Watt.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164470/AS. Price codes: A03 in paper copy; A01 in microfiche. Report No. G1217-01, September 1987. 33 p. Contract No. 14-08-0001-G-1217. Project No. USGS G-1217-01.

Descriptors: *Water Research Institutes, *Training, *Research, *Technology transfer, *District of Columbia, Anacostia, Ecology, Erosion, Sedimentation, Water quality, Wastewater, Hydrilla, Groundwater, Chesapeake Bay, Public education.

The D.C. Water Resources Research Center research program for FY 1986 focused on problems of major importance to the District of Columbia. These problems included the deterioration of the water quality of urban streams and related institutional concerns. This FY 1986 Institute Final Program Report describes the completed and continuing projects that the D.C. Water Resources Research Center conducted between August 1, 1986, and July 31, 1987. The projects entitled: 'The Ecology of the Anacostia River and the Neighboring Environs'; 'The Impact of Erosion and Sedimentation on the Anacostia'; 'The Enzymology of Hydrilla'; and 'The Extraction of Information on Water Quality Variables in the District of Columbia' are concerned with the Anacostia River, which is a tributary of the Potomac River. The project entitled: 'Measurement of 4-Nonylphenol in Water and Wastewater Effluents' addresses the fundamental issue of the development of a methodology for the measurement of 4-Nonylphenol which is a toxic by-product found in treated wastewater. The Technology Transfer/Public Education Program accomplishments included monthly seminars, symposia, exhibits, public tours, and publication of a quarterly newsletter. (Watt-D.C., WRRC)
W88-10004

FISCAL YEAR 1986 PROGRAM REPORT (ALASKA WATER RESOURCES CENTER),
Alaska Univ., Fairbanks. Water Research Center.
E. J. Brown.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164488/AS. Price codes: A03 in paper copy; A01 in microfiche. Report No. INE87.34, Report No. G1210-01, October 1987. 27 p, 1 tab. Contract No. 14-08-0001-G-1210. Project No. USGS G-1210-01.

Descriptors: *Water Research Institutes, *Alaska, *Training, *Research, *Information transfer, Riparian vegetation, Streamside vegetation, Aquatic biology, Permafrost, First-order streams, Streams, Sediment transport, Plant growth, Productivity, Microorganisms, Eutrophication, Growth kinetics, Nutrients, Phosphorus, Algae, Iron bacteria, Aquatic life, Yeast, Snowmelt, Runoff, Model studies, Snow-soil interaction, Nitrate, Nitrogen isotopes, Stable isotope tracers, Nitrogen geochemistry, Arsenic, Floods.

Six small projects were funded by the U.S. Geological Survey (USGS) federal cooperative water resource program in fiscal year 1986. One project studied stream ecology. Another project is contributing to an understanding of the growth mechanisms that control species composition in aquatic environments that have been perturbed by increased usage or intentional fertilization. Since existing snowmelt models do not incorporate some key high-latitude phenomena, another project modified an existing runoff model to incorporate the physical characteristics of the soils. Stable nitrogen isotopes are being used in another project to determine the sources of nitrate in groundwaters of interior Alaska. Another project has assessed streamflow sediment transport for engineering projects and, finally, one project published a risk assessment for arsenic contamination of a groundwater aquifer. During 1986, the Water Research Center administered about 30 water-related research projects and provided training to approximately 24 graduate students and several undergraduate assistants. Cooperative research and/or exchanges were made with Alaskan agencies, the U.S. Environmental Protection Agency, U.S. Geological Survey, the Alaska Cooperative Extension Service and the U.S. Department of Energy. (USGS)
W88-10005

FISCAL YEAR 1986 PROGRAM REPORT (UTAH WATER RESEARCH LABORATORY),
Utah Water Research Lab., Logan.
L. D. James.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164694/AS. Price codes: A03 in paper copy; A01 in microfiche. Program Report G1255-01, August 1987. 23 p, 7 ref. Contract No. 14-08-0001-G1255. Project No. USGS G1255-01.

Descriptors: *Water Research Institutes, *UTAH, *Research, *Training, *Information transfer, Deserts, Arid lands, Evaporation, Hydrologic budget, Hydrometeorology, Meteorological data collection, Energy, Bowen ratio, Atmospheric stability, Groundwater, Salinity, Water balance recharge/discharge, Drinking water, Groundwater pollution, Petroleum hydrocarbons, Toxicity, Public health, Surface sealing, Soil porosity, Soil surface, Hydraulic conductivity, Soil physics, Organic contaminants, Groundwater transport, Hazardous waste, Structure-activity relationships, Transport models.

Within the $3.1 million research program underway in 14 major program areas at the Utah Water Research Laboratory, two are being developed with USGS funds through the Utah Center for Water Resources Research. One area examines and quantifies fundamental meteorologic and surface and groundwater processes in closed desert basins in order to manage the limited water resources in these arid lands around desert playas better. The second addresses fundamental chemical and biological processes for protecting water supplies from hazardous wastes (largely petroleum-related in Utah). During FY86, UCWRR supported three projects on desert basin hydrology and two on protecting groundwater supplies from organic chemicals. The first project on desert hydrology developed instrumentation to measure precipitation and evaporation patterns across a transect of a remote desert valley and defined a grassy area between the mountains and the playa as the primary evaporation area and found a large amount of water to be stored but unable to evaporate through the salt crust in the center of the playa. The second project modeled groundwater flow from recharge areas near the mountains to discharge onto these grassy lands above a zone of large density gradients whose location moves between wet and dry years. The third project explored soil crusting above vesicular horizons with the goal of finding ways for reducing erosion from cloudbursts. One project on groundwater quality protection characterized petroleum products leaking from underground storage tanks and evaluated their toxicity by testing impacts on mice. The second is developing methods for estimating the partitioning behavior of organic contaminants in soil, water, and air from their molecular structure. (James-Utah Water Res. Lab)
W88-10007

FISCAL YEAR 1986 PROGRAM REPORT (CALIFORNIA WATER RESOURCES CENTER),
California Univ., Davis. Water Resources Center.
H. J. Vaux.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164314/AS. Price codes: A03 in paper copy; A01 in microfiche. Program Report G1213-01, August 1987. 37 p. Contract No. 14-08-0001-G1213. Project No. USGS G1213-01.

Descriptors: *Water Research Institutes, *Training, *Information transfer, *California, *Research, *Grants, Chemical transport, Complexation reclamation, *Irrigation, *Evaporation ponds, Saline drainage waters, Streams, Logging, DBCP, Furrow irrigation, Biodehalogenation.

This report contains a synopsis of the results of research projects sponsored under Grant No. 14-08-0001-G1213, the 1986 Water Research Institute Program (WRIP) for the University of California Water Resources Center. It also contains summaries of water problems and issues in California and the Water Resources Center's Program Goals and Priorities, Information Dissemination Activities and Cooperative Arrangements. The California WRIP package is a subset of the Center's overall research program and consists of six projects investigating the following topic areas: A Model for Dynamic Transport of Heavy Metals in Groundwater Systems, Structural Impacts of the Reclamation Reform Act of 1982 on Western Agriculture, Evaluation of Evaporation Ponds for Saline Drainage Waters, Application of a Paired Watershed Research Design to Evaluate Instream Effects of Watershed Management Activities in North Coastal Areas, Interaction of Nemagon (DBCP) with Constituents of Water-Soil Systems, and Furrow Irrigation Model Development and Evaluation. (Vaux-CA WRC)
W88-10008

FISCAL YEAR 1986 PROGRAM REPORT (MONTANA WATER RESOURCES CENTER),
Montana State Univ., Bozeman. Water Resources Research Center.
H. S. Peavy.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164645/AS. Price codes: A03 in paper copy; A01 in microfiche. Annual program Report G1236-01, August 1987. 32 p, append. Contract No. 14-08-0001-1236. Project No. USGS G1236-01.

Descriptors: *Water Research Institutes, *Montana, *Research, *Information transfer, *Education, Water supply, Algal toxins, Soil water, Acid mine drainage, Adsorption, Clay minerals, Model studies, Ecosystems, Cyanide.

The annual program of the Montana University System Water Resources Center includes research, education and information transfer. The 1986 program included seven research projects, one education/information transfer project and one information management project. Research projects addressed the following water problems: (1) Domestic water use patterns in small communities; (2) toxic algal blooms; (3) retention of water in soils; (4) acid mine drainage; (5) lake eutrophication; (6) water quality modeling; and (7) cyanides and heavy metal leaching from abandoned gold mining operations. The principal findings of these projects are reported in synoptic form. An information transfer project and an information management project were also a part of the program. Information transfer consisted of both formal and informal components. Formally, the Water Center maintained a reference service that distributed a list of documents available through the Water Center to over 600 subscribers. Approximately 200 requests are received for documents in response to each quarterly mailing. Other formal information transfer activities include a Water Issues Forum and publications resulting from previous years programs. Informally, the Director participated in

several meetings sponsored by other water related groups and testified before several legislative committee meetings. An information management program designed to provide input from the university community to the state Natural Resources Information System concluded a formal information management system. (Peavy-MT St. Univ.)
W88-10009

FISCAL YEAR 1986 PROGRAM REPORT (PENNSYLVANIA CENTER FOR WATER RESOURCES RESEARCH).
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164611/AS. Price codes: A03 in paper copy; A01 in microfiche. Program Report G1248-01 (Report ER8713), August 1987. 30 p. Contract No. 14-08-0001-G1248. Project No.USGS G1248-01.

Descriptors: *Water Research Institutes, *Research, *Information transfer, *Training, *Pennsylvania, Acid rain, Streams, Water quality, Drought, Water treatment, Giardia, Groundwater, Water supply.

Three projects and a program of technology transfer were conducted during Fiscal Year 1986. Focused on acid rain, protection of domestic water supplies and drought management strategies, the program addressed state as well as regional priorities. Complementing the Institute's continuing program on acid precipitation and its effects, a study was initiated to identify mechanisms of acidity transport during episodic events, to provide a basic understanding of how streams are being acidified by acid rain. In a second study, researchers concluded that drought indicators, now in use by the state, provide valid information about the onset and termination of drought. Statistical properties of existing drought indicators and their associated trigger points are now established. A third laboratory study demonstrated the feasibility of using specific coagulants in conjunction with diatomaceous earth filtration to remove Giardia muris from water supplies. The Institute's 1986 technology transfer effort emphasized programs dealing with groundwater resources and contamination, water supply and treatment. (McDonnell-PA St. Univ.)
W88-10010

FISCAL YEAR 1986 PROGRAM REPORT (TENNESSEE WATER RESOURCES RESEARCH CENTER).
Tennessee Univ., Knoxville. Water Resources Research Center.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164702/AS. Price codes: A03 in paper copy; A01 in microfiche. Program Report G1253-01, August 1987. 25 p, 1 fig. Contract No. 14-08-0001-G1253. Project No. USGS G1253-01.

Descriptors: *Water Research Institutes, *Tennessee, *Training, *Research, *Information transfer, Hazardous waste disposal, Waste treatment, Wetlands, Resource management, Wetlands protection, Levees, Dikes, Flood Control, Flood Profile.

The FY86 research program accomplished by the Tennessee Water Resources Research Center under the U.S. Department of Interior's State Water Resources Research Institute Program is described. Three research projects and information transfer activities are reviewed. Project 02 has concentrated on the development and refinement of a methodology (i.e., model) to determine the need for hazardous waste treatment, storage and disposal facilities based on the amount and types of wastes generated within Tennessee. The project included a workshop designed to examine changes in industrial hazardous waste management practices resulting from changes in regulations, economics and technologies. Project 03 focused on identification and evaluation of alternative approaches to the protection and management of wetlands in Tennessee. A majority of remaining wetlands areas in the state are under private ownership. The results of this project provide a summary of remaining wetlands in the state, an analysis of the potential for conversion and future use of these wetlands, and an evaluation of possible management strategies which could be used to protect these resource areas. Project 04 involved the completion of a two-year research project that investigated the problems related to the construction of private levees in the floodplains of West Tennessee river systems. Phase I of the project identified the nature and extent of levee problems and evaluated the hydraulic impacts of these levees on potential downstream and upstream flooding. Phase II focused on the legal, political, and regulatory ramifications of levee control in Tennessee and concluded with development of a recommended plan of action for dealing with private levee construction. The information transfer program involved conferences and workshops, publication of technical reports, and the orderly transfer of current information to water resources researchers, administrators and the general public. (Gangaware-Univ. TN, WRRC)
W88-10012

FISCAL YEAR 1986 PROGRAM REPORT (WISCONSIN WATER RESOURCES CENTER),
Wisconsin Univ., Madison. Water Resources Center.
G. Chesters, and K. Sherman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164652/AS. Price codes: A04 in paper; A01 in microfiche. Program Report G1261-02, August 1987. 46 p. Contract No. 14-08-0001-G1261. Project No. USGS G1261-02.

Descriptors: *Water Research Institutes, *Research, *Information transfer, *Training, *Wisconsin, Groundwater, Nonpoint source pollution, Groundwater flow, Aquifer characteristics, Model studies, Computer modeling, Wetlands, Glacial aquifers, Lake dynamics, Management planning, Fluid mechanics, Hydraulic properties, Flood routing.

As in the past several years, the FY86 Wisconsin Water Resources Center's annual program centered on groundwater quality. Projects that focused on the economic and institutional perspectives of groundwater contamination and how these factors influence public and private decisions augmented the technical aspects of the program. In addition, the important issues of flood routing, nonpoint source pollution, and alteration of Great Lakes coastal wildlife habitats were addressed. Maintenance and expansion of the Water Resources Reference Services collection and the retrieval and dissemination of water-related information have proved beneficial to university faculty, staff and students, state agency personnel, state legislators and other decisionmakers, private consultants, environmental groups, and the general public. During FY86 the Water Resources Center continued to provide training for undergraduate and graduate students. Nine graduate and three undergraduate students received training and practical experience in the areas of photointerpretation and image analysis, geology and geophysics (hydrogeology), urban planning, water analysis and field studies, mapping techniques, scientific report writing, civil and environmental engineering, flood routing, presentation of results at professional meetings; hourly help students in the information dissemination projects were provided with training in library reference services, computer cataloging, etc. (Chesters-WI WRC)
W88-10013

FISCAL YEAR 1986 PROGRAM REPORT (OREGON WATER RESOURCES RESEARCH INSTITUTE),
Oregon State Univ., Corvallis. Water Resources Research Inst.
P. C. Klingeman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164710/AS. Price codes: A03 in paper copy; A01 in microfiche. Program Report G1247-01, August 1987. 40 p, 2 tab. Contract No. 14-08-0001-G1247. Project No. USGS G1247-01.

Descriptors: *Water Research Institutes, *Research, *Information transfer, *Training, *Oregon, Groundwater, Soils, Metals, Leachate, Extraction, Hydrophobic organic compounds, Partition coefficient, Chemical transport, Biodegradation, Microbial degradation, Groundwater pollution, Groundwater transport, Sorption, Toxicity, Aquatic habitats, Habitat enhancement, Viral indicators, Fecal pollution, Coliform standards, Estuaries, Shellfish, Iron-limitation, Eutrophication, Cyanobacteria, Lake management, Cyanophyta.

The FY 1986 Oregon Water Resources Research Institute program included six research projects addressing critical water problems in Oregon. Three projects advanced understanding of potential means for the protection of groundwater resources: project 02, Laboratory Study of In-Situ Reclamation Process for Metals-Contaminated Soils; project 03, Sorption and Transport of Aqueous Gasoline Contaminants in Soil and Aquifer Sediments; and project 04, Effect of Sorption on Bacterial Metabolism of Trace Toxicants in Groundwater Aquifers. Two projects developed analytical techniques for evaluating the effectiveness of protection measures for aquatic ecosystems: project 05, Hierarchical Analysis of Salmonid Habitat Improvement Programs Within the John Day Drainage; and project 06, Microbiological Quality of Estuarine Waters. One project provided a technique for improved detection of lake water eutrophication problems: project 07, Development of Field Assay of Iron Limitation in Nutrient-Rich Lakes. Brief individual summaries of these research projects and their principal research findings are presented. The FY 1986 Oregon WRRI program also included education and training activities. This directly involved 40 graduate students from across campus in WRRI interdisciplinary seminars plus 9 graduate students and 4 undergraduates in research training on WRRI projects. Information transfer activities were also a routine part of the WRRI program. (Klingeman-OR. St. Univ. WRRI)
W88-10014

FISCAL YEAR 1986 PROGRAM REPORT (OHIO WATER RESOURCES CENTER),
Ohio State Univ., Columbus. Water Resources Center.
R. C. Stiefel.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164769/AS. Price codes: A03 in paper copy; A01 in microfiche. Program Report G-1245-01, August 1987. 38 p, 17 ref. Contract No. 14-08-0001-1245. Project No. USGS G1245-01.

Descriptors: *Water Research Institutes, *Ohio, *Training, *Research, *Information transfer, Fluidized bed process, Biological wastewater treatment, Phenols, Draft tube, Kinetics, Adsorption, Cadmium assimilation, Sediment bacteria, Aquatic environment, Lake Erie, Water demands, Simulation analysis, Time series analysis, Municipal water, Safe yield, Risk-benefit analysis, Brine disposal, Waste disposal wells, Input-output analysis, Oil and gas industry, Groundwater, Economics.

Water is one of Ohio's most important natural resources, and the State has an adequate supply to meet its immediate needs. Most of Ohio's water problems are associated with water quality. Of primary concern are the sediments, nutrients and acids in the surface waters from urban, agricultural and mining areas and the toxic and hazardous wastes that threaten the ground and surface waters. The focus of the 86 State Water Research Program was directed at some of these needs. One project examined the simultaneous adsorption and biodegradation that occurs in a three-phase fluidized bed that utilizes immobilized living microorganisms in an aerobic wastewater treatment process. Another project studied the specific mechanisms that certain bacteria have developed to resist inhibition caused by cadmium in the environment and to investigate the potential that these organisms have in the translocation of this highly toxic metal. A third project developed methodology to determine the impact that seasonal water usage has on the safe yield that can be provided from reservoirs used to supply municipal drinking water. The

fourth project analyzed the risks and benefits that occur from disposing of oil and gas brines by injecting them in the annulus of producing oil and gas wells in the state. Training was provided through this program for nine students enrolled in five disciplines at two universities in the State. (Stiefel-OH St. Univ. WRC)
W88-10016

FISCAL YEAR 1986 PROGRAM REPORT (LOUISIANA WATER RESOURCES RESEARCH INSTITUTE).
Louisiana Water Resources Research Inst., Baton Rouge.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-164744/AS. Price codes: A03 in paper copy; A01 in microfiche. Program report G1228-01, October 1987. 25 p. Contract No. 14-08-0001-G1228. Project No. USGS G1228-01.

Descriptors: *Water Research Institutes, *Research, *Training, *Information transfer, *Louisiana, Flood frequency, Flood forecasting, Statistical methods, Stochastic processes, Herbicides, Biodegradation, Pollutants, Transport depletion, 2,4-D, 2,4,5-T, Hydrogeology, Groundwater, Recharge, Tritium, Aquifers, Entropy, Hydrocarbons, Chemical wastes, Permeability coefficient, Dispersion, Adsorption.

The Louisiana Water Resources Research Institute's Fiscal Year (FY) 1986 Research Program addressed crucial water resources problems that were identified by the National Association of Water Institute Directors (NAWID) as priority problems for Louisiana and the Southern Plains Region. The areas researched: water quality, groundwater hydrology, and flooding, were also important issues for the nation as a whole. The Institute funded three new projects and two continuation projects (one receiving a no-cost extension from FY 1985). Flooding was the topic of two projects, one new and one continued from FY 1985. Specifically addressed were analyses of flood frequency and magnitude (Project 02 and 05). Water quality research addressed by the FY 1986 program focused on contaminant transport theory. Two projects contributed to this area, one studying chlorinated hydrocarbons (no-cost extension project) and the other, biocidal agents (Project 03). The remaining project (Project 04) performed tritium dating of water in the Baton Rouge aquifer recharge area. This project is expected to contribute information needed in answering questions on the importance of protecting this aquifer's recharge area. (Tittlebaum-LA St. Univ. WRRI)
W88-10017

FISCAL YEAR 1986 PROGRAM REPORT (IDAHO WATER RESOURCES RESEARCH INSTITUTE),
Idaho Univ., Moscow. Water Resources Research Inst.
G. L. Bloomsburg.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-161476/AS. Price codes: A03 in paper copy; A01 in microfiche. Annual Report No. G1222-01, July 1987. 29 p. Contract No. 14-08-0001-G1222. Project No. USGS G1222-01.

Descriptors: *Administration, *Water Resources Institutes, *Information exchange, *Training, *Research, *Idaho, Drawdown, Boise Geothermal System, Data retrieval, Data storage, Flow statistics, Drought, Systems analysis, Irrigation systems, Groundwater pollution, Lakes, Nutrients, Mine wastes.

This report describes the research and information dissemination activities of the Idaho Water Resources Research Institute during the 1986 fiscal year. Synopses are presented for the following research projects: Analysis of Historical and Current Drawdown and Production Data from the Boise Geothermal System; A SAS Based Hydrological Storage and Retrieval System; Annual Flow Statistics and Drought Characteristics for Gaged and Ungaged Streams in Idaho; Development and Evaluation of Procedures for Systems Analysis and Optimization of On-Farm Irrigation Systems; Groundwater Management under the Appropriation Doctrine, Part II; Power Engine Discharges as a Nutrient Source in High-Use Lakes; A New Approach to Evaluate Redox Status and Groundwater Pollution Problems Associated with Mine Wastes in the Coeur d' Alene Mining District, Idaho. Information dissemination and workshop activity of the Institute is also reported. (Bloomsburg-IWRRI)
W88-10019

FISCAL YEAR 1986 PROGRAM REPORT, (CONNECTICUT INSTITUTE OF WATER RESOURCES),
Connecticut Univ., Storrs. Inst. of Water Resources.
D. F. Squires.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-161062/AS. Price codes: A03 in paper copy; A01 in microfiche. Report No. G1215-01, October 1987. 27 p. Contract No. 14-08-0001-G1215. Project No. USGS G1215-01.

Descriptors: *Water Research Institutes, *Research, *Information transfer, *Training, *Connecticut, Groundwater, Surface water, Model studies, Leachates, Aggregates, Waste disposal, Slag, Organic waste, Hazardous waste, Electrodes, Heavy metals, Metal deposition, Electroplating, Wastewater treatment, Chitin, Chitosan, Shellfish waste, Metal wastes, Wetlands, Acid precipitation.

Connecticut's Institute of Water Resources 1986-87 research and information transfer projects focused on water quality management and protection, hydrologic cycle modeling, wetland restoration, and acid precipitation. Funded research projects included: design and testing of an interactive ground and surface water hydrologic model (02); sorption of organic pollutants by different soil types (03); use of crustacean shell wastes to remove metal ions from wastewater (04); design and testing of an improved method for electrochemical recovery of metals from wastewater (06); and, investigation of the effects of acid precipitation on slag-based concrete aggregates (05). Information transfer conference topics included: wetlands creation and restoration, metal recovery from wastewater, and acid precipitation. (Jokinen-Univ. CT)
W88-10020

FISCAL YEAR 1986 PROGRAM REPORT (IOWA WATER RESOURCES RESEARCH INSTITUTE),
Iowa State Water Resources Research Inst., Ames.
T. A. Austin.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-156427/AS. Price codes: A03 in paper copy; A01 in microfiche. Annual Report No. G1225-01, (1987). 35 p. Contract No. 14-08-0001-G-1225. Project No. USGS G-1225-01.

Descriptors: *Water Research Institutes, *Iowa, *Research, *Training, *Information transfer, Evapotranspiration, Groundwater recharge, Hydrologic models, Rainfall infiltration, Percolation, Surface runoff, Soil moisture deficiency, Unsaturated flow, Finite element method, Algae, Algal growth, Ammonium, Diurnal distribution, Nitrates, Nitrogen removal, Secondary wastewater treatment, Erosion, Soil losses, Sediments, Rivers, Leaching, Fertilizer, Water quality, Nitrogen, Nonpoint pollution sources, Soil sampling.

The Iowa State Water Resources Research Institute FY 1986 research program (University of Iowa and Iowa State University) was funded by the U.S. Department of the Interior, Geological Survey. The research program was centered in three areas critical to Iowa's natural resource program pertaining to water: (1) Nitrogen and Pesticide Transformation, Fate and Transport; (2) Erosion; and (3) Groundwater Management. Federal competitive funds were used to initiate two new projects concerning the use of soil sampling and modeling to estimate nitrate-nitrogen leaching and to investigate mechanisms of bank erosion along rivers. One study on diurnal patterns of nitrogen loading in streams was completed. One study was terminated because of changing priorities for research. A summary of each project is included in this Annual Report. (Austin-Iowa St. Univ.)
W88-10023

FISCAL YEAR 1986 PROGRAM REPORT (MAINE LAND AND WATER RESOURCES CENTER),
Maine Univ. at Orono. Land and Water Resources Center.
G. K. White.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88 186291. Price codes: A03 in paper copy; A01 in microfiche. Program Report G1229-01, July 1987. 20 p, 8 ref, 4 append. Contract No. 14-08-0001-G1229. Project No. USGS G1229-01.

Descriptors: *Water Research Institutes, *Research, *Information transfer, *Training, *Maine, Acid rain, Aluminum, Bedrock, Chemical analysis, Chemical precipitation, Computer models, Denitrification, Drinking water, Effluents, Fissure water, Flow characteristics, Forests, Groundwater, Groundwater pollution, Leaching, Nitrates, Pumping tests, Sediments, Septic tanks, Soil dynamics, Statistical analysis, Streams, Trace metals, Wastewater, Wells.

Four research projects and an information transfer component were funded in FY-86. 'An Investigation into the Effects of Site Disturbance on the Mobilization of Accumulated Trace Metals from Forest Floors and the Implications for Groundwater Quality' (G1229-02) led to the collection and chemical analysis of 202 soil samples from control sites and from sites disturbed by mechanical harvesting and fire. Preliminary observations are that relatively little mechanical alteration of soils was evident due to the various disturbances except in the O horizon and that fire had the most dramatic effect on forest floor character and chemical composition. In 'Terrestrial Versus In-stream Sources of Dissolved Aluminum During Episodic Low pH Events' (03), preliminary evaluation indicates that total dissolved Al reached a peak 6-22 hr after acidification began and then began to decline. The different substrates of the sampled stream beds play an important role in affecting the pH buffering process downstream from the source of the acid. The 'Reduction of Nitrate Contamination of Groundwater by Septic Tank Effluent' (-04) study has evaluated two brands of trickling filter media and one random media. Up to 85-95% reduction in BOD was achieved, allowing for 60-65% nitrogen removal. These rates are insufficient to reduce nitrate concentrations to the 10 mg N03 -N/l standard. 'Probabilistic Model for Flow in Fissured Bedrock' (-05) has produced a computer model which generates complete fracture networks using limited field data. It is possible to produce a three-dimensional image of the network on the screen as well as to predict the volume and speed of flows through the fissures. ' Information Transfer in Water Resources Management' (-22) was carried out through a variety of publications and slide programs including a series of information digests on safe water for household consumption, revisions of bulletins of giardia and radon, a major publication on 'The Forests of Maine' with a section on the impact of forest management practices on the use and quality of Maine's lakes and rivers and a slide-tape program on Maine's groundwater resources. (Landry-U. ME, LWRC)
W88-10026

FISCAL YEAR 1986 PROGRAM REPORT (COLORADO WATER RESOURCES RESEARCH INSTITUTE),
Colorado State Univ., Fort Collins. Water Resources Research Inst.
N. A. Evans.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88 180427/AS. A03 in paper copy, A01 in microfiche. Program Report G1214-01, Annual Report No. 23, August 1987. 35 p. Contract No. 14-08-0001-G1214. Project No. USGS G1214-01.

Descriptors: *Water Research Institutes, *Research, *Information transfer, *Training, *Colorado, Conjunctive use, Groundwater management, Water law, Augmentation plans, Groundwater recharge, Geochemistry, Recharge wells, Irrigation efficiency, Water transfer, Conjunctive use, Hydrologic models, Economic evaluation, Groundwater, Nuclear magnetic resonance, Specific yield, Reservoir operation, Channel scour, Synthetic flows, Crane habitats, Groundwater pollution, Computer models, Finite method, Water reuse.

The Institute's Federal FY1986 Program consisted of six research projects focused on the following Colorado problems: (1) Conjunctive Surface-Groundwater Management - Augmentation, Exchanges and Substitute Supply; (2) Geochemical Assessment of Aquifer Recharge Effects in the South Platte Denver Basin; (3) Incentives for Improving Irrigation Efficiency in the South Platte Basin; (4) Specific Yield of Denver Basin Aquifer from Nuclear Magnetic Resonance; (5) Alternatives for Meeting Crane Habitat Requirements; and (6) Reuse of Treated Wastewater by Groundwater Recharge. The Institute provided supplemental funding for the following projects: (1) Hydrologic Effects of Gravel Quarry Operations; (2) Evapotranspiration by Phreatophytes in the Closed Basin, San Luis Valley; (3) Examinations of Management Options for the South Platte River Basin; (4) Groundwater Faunas as Indicators of Groundwater Quality in the South Platte River System; and (5) a Chemigation-Valve Testing Program. The appropriation also helped provide an effective Institute technology transfer program, fully integrated with its water research and development program. This includes: newsletter; three publications series; a 'library list' of new water resources research reports and publications; Project AWARE, designed to keep State and Federal agency personnel aware of proposed research; public water policy education (programs including slide presentations); and workshops, seminars, and small group consultations involving potential users of research products. The Colorado Legislature reaffirmed its support of water research by extending the Institute's status as the designated water research management center in Colorado for ten years. (USGS)
W88-10031

FISCAL YEAR 1986 PROGRAM REPORT (WASHINGTON WATER RESEARCH CENTER).
Washington State Water Research Center, Pullman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-156062/AS. Price codes: A03 in paper copy; A01 in microfiche. Program Report G1259-01, August 1987. 22 p. Contract 14-08-0001-G1259-01. USGS Project G1259-01.

Descriptors: *Water Research Institute, *Washington, *Research, *Training, Information transfer, Consumptive use, Evapotranspiration, Data requirements, Fish guiding structures, Fish passages, Fish protection, Groundwater, Groundwater pollution, Intakes, Iron oxides, Irrigation requirements, Mathematical models, Forebay, Non-point pollution sources, Pesticides, Phosphorus bioavailability, Simulation model, Soil absorption capacity, Soil columns, Soil horizons, Traveling screens, Urban runoff, Water conservation, Water costs, Water markets, Water pollution sources, Water quality control, Water requirements, Watershed management.

A system of nineteen dams on the Columbia and Snake River systems utilizes hydropower to product 17,000 megawatts of electricity and furnishes 80% of the power needs of the region. Approximately 8.3 million acres of farmland are irrigated in the Pacific Northwest and provide 65% of the total direct farm income. The river flows and watershed drainage account for 50,000 miles of streams and 8,000 freshwater lakes in the state and give rise to widespread recreational boating, swimming, and fishing as well as commercial fishing. The sport and commercial fishing industry employ over 22,000 individuals and the wholesale value of salmon caught annually is over $90 million. Research efforts into the mitigation of water shortages during critical low flow and reduction in competitive uses were addressed including the investigation of temporary sale of water rights. Water markets would be created whereby water could be sold by farmers during a low-flow year to insure firm hydropower potential. Possible implementation of a computer-based irrigation scheduling system to encourage energy, soil, and water conservation, as well as the reduction of operation costs was investigated. To manage lakes better, new or modified computer models must be developed to incorporate the bioavailability to limiting nutrients as well as mechanisms to take into account individual differences of watersheds and lakes. Lake Sammamish was used to test an existing lake response model and its recalibration. For better management of aquifers, it is essential the extent of the contamination as well as the steady-state and dynamic behaviors of sources of contamination be better understood. Parameter identification techniques for characterizing groundwater contaminants was undertaken and an understanding of how the retention and transport of the pesticides occur in the alluvial soils of Washington was investigated. The effect of turbine intake geometry was studied in order to develop better design for the protection of migrating anadromous fishes through power house structures of dams. (Funk-WA St. WRC)
W88-10044

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN WYOMING, FISCAL YEARS 1986 AND 1987,
Geological Survey, Cheyenne, WY. Water Resources Div.
S. L. Green, and J. R. Schuetz.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Open-File Report 87-532, 1987. 118 p, 5 fig, 8 tab.

Descriptors: *Hydrologic data, *Wyoming, Streamflow, Sediment load, Water quality, Groundwater, Water supply, Environmental effects, Oil shale.

The two types of water-resources activities of the Wyoming District are collection of hydrologic data and water-resources-appraisal projects. Much of the work is done in cooperation with other agencies; during fiscal year 1986 and 1987 cooperators included eight State agencies, two counties, one municipality and seven Federal agencies. This report serves both as a biennial progress report to the cooperating agencies and the general public, and as one means of coordination of water-resources activities with other agencies. Lists and location maps are included for 162 streamflow stations, 15 reservoirs stations, 107 surface-water-quality stations, 24 sediment stations, and 89 groundwater observation wells, all of which were in operation at the beginning of water year 1987. During fiscal years 1985 and 1986, 12 streamflow stations, 39 surface-water-quality stations, six sediment stations, and five groundwater-observation wells were discontinued. Descriptions, location maps, and progress statements are given for four data-collection projects and 23 water-resources-appraisal projects that were active (funded) during fiscal year 1986 and (or) fiscal year 1987. Also included are a list of nine projects for which funding ended prior to 1986 and that are completed except for the final report(s), and a list of four new projects that will be funded during fiscal year 1987. The final section of the report is a bibliographic listing of reports about the water resources of Wyoming, prepared by the U.S. Geological Survey authors. (USGS)
W88-10053

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN PENNSYLVANIA, 1986-87,
Geological Survey, Harrisburg, PA. Water Resources Div.
R. E. Helm.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80255. USGS Open-File Report 87-475, 1987. 119 p, 7 fig.

Descriptors: *Pennsylvania, *Water resources data, *Hydrologic data collections, Flood-Prone Area Maps.

The U.S. Geological Survey's water-resources activities in Pennsylvania are described. Some activities are topics of general interest to the water resources community while others are related to current water issues. The report also describes the mission of the Water Resources Division of the U. S. Geological Survey, and program funding, water issues, a listing of selected literature on water resources in Pennsylvania, and how to obtain reports and information. (USGS)
W88-10059

WATER-RESOURCES ACTIVITIES OF THE LOUISIANA DISTRICT IN FISCAL YEARS 1986-87,
Geological Survey, Baton Rouge, LA. Water Resources Div.
E. A. Ellsworth.
Available from the OFSS, USGS, Box 25425, Lakewood, CO 80225. USGS Open-File Report 87-225, 1987. 53 p, 8 fig, 3 append.

Descriptors: *Groundwater, *Surface waters, *Water quality, *Louisiana, Aquifers, Floods, Rivers, Mississippi River, Calcasieu River, Vermilion River, Chicot aquifer system, Sparta aquifer.

The U.S. Geological Survey conducts three types of water resources activities in Louisiana - data collection, investigations, and research. These activities are conducted, in large part, through cooperation with other Federal, State, and local agencies. Water-resources activities undertaken from October 1, 1985 to September 30, 1987 are described. Specifically, the report presents information on organization of the District Office, cooperating agencies, data-collection activities, interpretive studies and research activities, new publications of the Louisiana District, and sources of information in the U.S. Geological Survey. For each activity, the following information is presented: project title, project number, study location, cooperating agency, project chief, project duration, problem, objective, approach, progress, and plans. (USGS)
W88-10060

10. SCIENTIFIC AND TECHNICAL INFORMATION

10A. Acquisition And Processing

STATUS OF THE NATION'S WATER QUALITY INFORMATION ACTIVITIES.
Geological Survey, Reston, VA. Office of Water Data Coordination.
For primary bibliographic entry see Field 7C.
W88-09039

STATE GROUND WATER DATA MANAGEMENT,
Sewall (James W.) Co., Old Town, ME.
For primary bibliographic entry see Field 4B.
W88-09482

10C. Secondary Publication And Distribution

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National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W88-09558

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DATA BASE MANAGEMENT SYSTEM APPROACH TO GROUND WATER MANAGEMENT,
For primary bibliographic entry see Field 4B.
W88-09279

10F. Preparation Of Reviews

AQUIFER ANALYSIS: A COMPREHENSIVE COLLECTION OF THE MOST IMPORTANT LITERATURE RELATING TO AQUIFER ANALYSIS.
For primary bibliographic entry see Field 2F.
W88-08985

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